This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

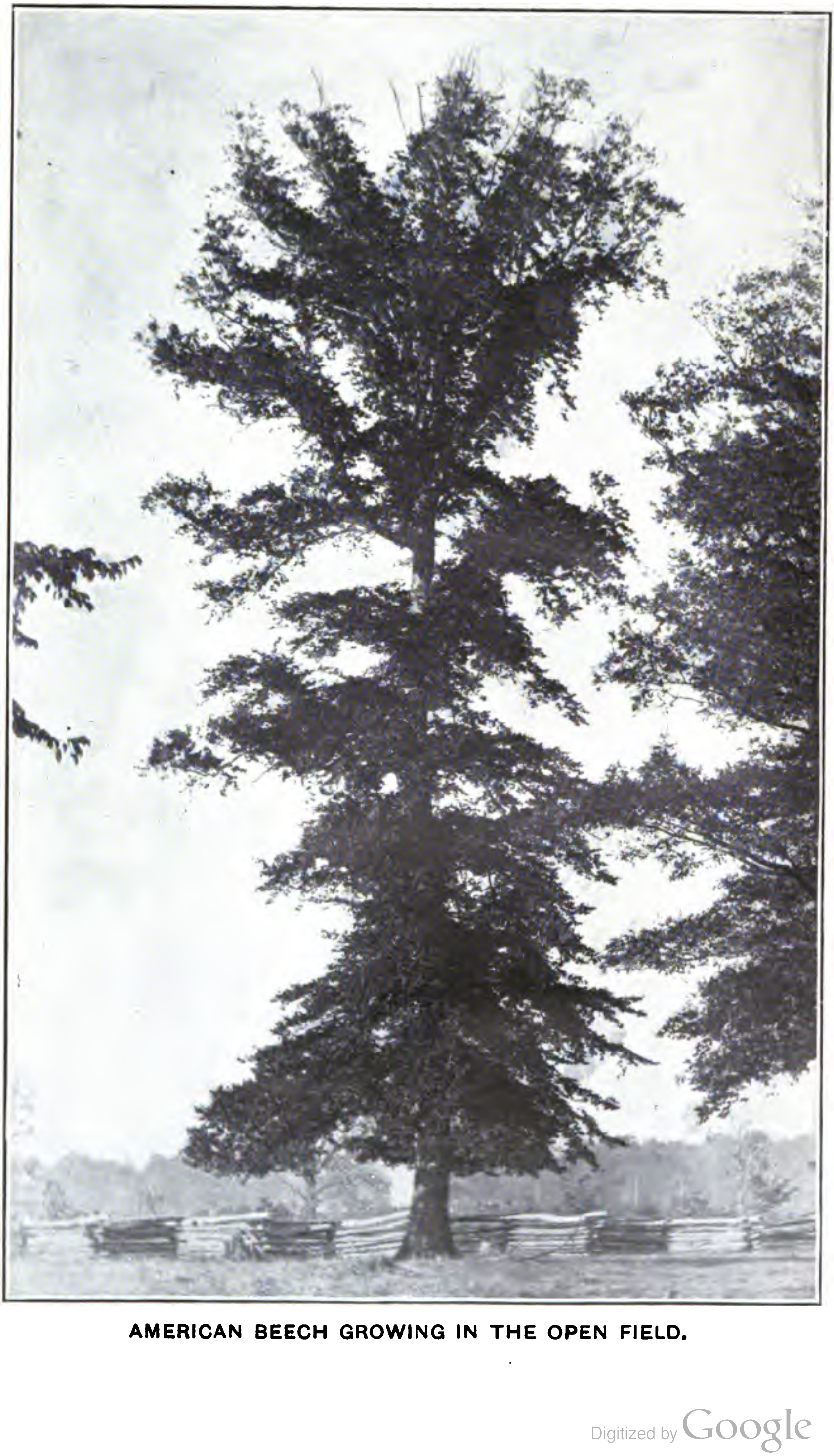
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

THE GIFT OF
State Library

SII
12
.I7



AMERICAN BEECH GROWING IN THE OPEN FIELD.

STATE OF INDIANA

FIFTH ANNUAL REPORT

OF THE

State Board of Forestry

1905

W. H. FREEMAN, SECRETARY

TO THE GOVERNOR OF INDIANA

INDIANAPOLIS:
WM. B. BURFORD, CONTRACTOR FOR STATE PRINTING AND BINDING
1906

STATE OF INDIANA,
EXECUTIVE DEPARTMENT,
INDIANAPOLIS, December 18, 1905.

Received by the Governor, examined and referred to the Auditor of State for verification of the financial statement.

OFFICE OF AUDITOR OF STATE,
INDIANAPOLIS, December 22, 1905.

The within report, so far as the same relates to moneys drawn from the State Treasury, has been examined and found correct.

WARREN BIGLER,
Auditor of State.

December 22, 1905.

Returned by the Auditor of State, with above certificate, and transmitted to Secretary of State for publication, upon the order of the Board of Commissioners of Public Printing and Binding.

FRED L. GEMMER,
Secretary to the Governor.

Filed in the office of the Secretary of State of the State of Indiana, December 23, 1905.

DANIEL E. STORMS,
Secretary of State.

Received the within report and delivered to the printer December 28, 1905.

HARRY SLOUGH,
Clerk Printing Bureau.

Table of Contents.

PAGE

Official Members of Board.................................... 5

Letter of Submittal to the Governor.................................... 6

Financial Statement from November 1, 1904, to October 31, 1905... 7- 8

Preface.................................... 9- 10

Report of Improvements, Experiments and Conditions at State Forest Reservation and Experimental Station.................................... 11- 26

- Driveways.................................... 11- 13
- Reservoirs.................................... 13- 15
- Administration Building.................................... 15- 18
- Fence-building.................................... 18
- Miscellaneous.................................... 18- 19
- Seed Planting, 1904.................................... 19- 20
- Seed Planting, 1905.................................... 20- 21
- Seedling Transplanting.................................... 21- 22
- Tree cultivation.................................... 22- 24
- Forest Cultivation.................................... 24- 26

Some Facts for Thinkers.................................... 27- 33

- The Purposes and Aims of the Forest Reservation.................................... 27- 28
- The Land Investment Value of the Institution.................................... 28- 29
- The Forest Value of the Institution.................................... 29- 32
- The Financial Investment and Interest.................................... 32- 33

Report of the Office Work.................................... 35- 41

- Instructions and Recommendations.................................... 37- 39

Forest Fire Legislation.................................... 41- 42

Legislation for the Exemption from Taxation of Forest Lands.... 43

Hardwood Forest Estates.................................... 44

The Trimming of Shade Trees (Benj. W. Douglass).................................... 45- 64

A List of Trees Recommended for City Planting (Benj. W. Douglass).................................... 65- 83

- Elm.................................... 69
- Maples.................................... 69
- Tulip Tree.................................... 71
- Horse Chestnut.................................... 71
- Hackberry.................................... 71
- Walnut.................................... 72
- Hickory.................................... 73
- Beech.................................... 75
- Chestnut (American).................................... 75
- Catalpa.................................... 75
- Black Cherry.................................... 77
- Oaks.................................... 77
- Ash.................................... 78
- Sycamore.................................... 79

152958

PAGE
Kentucky Coffee Tree.................................... 79
Ailanthus 79
Linden 80
Mulberry 81
Sassafras 81
Honey Locust 81
Black Locust 81
Sweet Gum 82
White Pine 82
Spruce 82
Some Insect Pests of Indiana Trees (Benj. W. Douglass).......... 83- 95
San Jose Scale.................................... 84- 88
Putnam Scale 88
Scurfy Scale 88
Cottony Maple Scale............................... 88- 89
Elm Tree Borer.................................... 89- 91
Elm Leaf Beetle................................... 91- 92
Elm Leaf Caterpillar.............................. 92- 93
Insecticides and Their Preparation................... 93- 95
Lime-Sulphur-Salt Wash 94
Whale-oil-Soap Wash 94- 95
Kerosene Emulsion 95
Paris Green 95
Thirty Timber Trees of Indiana (Benj. W. Douglass)............. 96-132
Juglans nigra (Black Walnut) 97
Juglans cinerea (White Walnut)..................... 97
Hicoria ovata (Shellbark Hickory) 97
Hicoria laciniosa (Kingnut Hickory)................ 97
Hicoria glabra (Pignut Hickory).................... 97
Populus deltoides (Cottonwood) 98
Fagus Americana (Beech) 98
Castanea dentata (Chestnut) 98
Quercus rubra (Red Oak)............................ 98
Quercus palustris (Pin Oak) 98
Quercus velutina (Black Oak)....................... 99
Quercus alba (White Oak) 99
Quercus macrocarpa (Burr Oak) 99
Quercus prinus (Rock Chestnut Oak)................. 99
Quercus acuminata (Chinquapin Oak)................. 99
Ulmus Americana (American Elm)..................... 100
Ulmus fulva (Slippery Elm)......................... 100
Liriodendron tulipifera (Yellow Poplar)............ 100
Platanus occidentalis (Sycamore)................... 100
Prunus serotina (Wild Black Cherry)................ 100
Gleditsia triacanthos (Honey Locust)............... 101
Gymnocladus dioica (Kentucky Coffee Tree).......... 101
Robinia psudacacia (Black Locust).................. 101
Acer rubrum (Red Maple)............................ 101
Acer saccharum (Sugar Maple)....................... 101

PAGE
Acer nigrum (Black Sugar Maple) 102
Tilia Americana (American Linden) 102
Fraxinus Americana (American Ash) 102
Fraxinus nigra (Black Ash) 102
Catalpa speciosa (Catalpa) 102
The Insect Enemies of Native Forest Trees as Studied Upon the Reserve (Geo. Ade Davis and Arthur J. Haltom) 133-180
The Oaks 138-146
The Hickories 146-149
Yellow Pine 149
Large Toothed Aspen 149
The Red Birch 150
The Beech 151
Yellow Poplar 151
The Maples 151
The Walnuts 151
The Chestnut 152
The Sycamore 152
The Gums 152
Insects 153
Nut Weevil 153
Cicadas, or Harvest Flies 154
Spiny Oak Slug 155
Oak Pruner 156
Northern Brenthid 156
Flat-Headed Borers 156
Yellow-necked Caterpillars 157
Gall Flies 157
Canker Worms 159
Painted Hickory Borer 159
The Heartwood Borer 161
Pine Bark Beetle 161
Sap Beetles 161
Engraver Beetles, Bark Beetles 161
Plant Lice 163
Ants 164
Click Beetles 164
Stag Beetles 165
Long-horned Beetles 165
Plant Scale 165
Lady Bug 165
Leaf Hoppers 166
Tree Hoppers 166
Ichneumon Flies 166
Leaf Beetles 169
Leaf Rollers 172
Twig Beetles 172
Hickory Bark Beetles 172
Locust Borer 173

PAGE
Animal Life Upon the Reserve and Its Relation to Insect Forms...173-177
- Remedies 177
- Conclusion 179
- Recommendations 179-180

Some Trees to Plant for Railroad Ties, Fence Posts and Line Construction Poles 181-192
- Chestnut 181
- Catalpa 182
- Kentucky Coffee Tree........ 185
- Black Locust 186
- Osage Orange 188
- Black Walnut 189
- Wild Cherry 190

Seeds and Seedlings for Forestry Planting........192-198
- Seeds 192
- The Nursery 195
- Soil Preparation 196
- Tree Cuttings 197

Seedling Transplanting 198

The Forest in the Life of a Nation........ 200

The Forest Policy of France........ 205

Work of the Pennsylvania Railroad in Planting Timber for Cross-ties 209

The Relation of Forest Reserves to the Mining Industry, by Maj. F. A. Fenn........ 213

Influence of Tree Planting Upon the Duty of Water in Irrigation, by F. H. King........224-240
- Influence of Wind-breaks upon Vegetation........ 224
  - Table 229
- Influence of Woods Upon the Rate of Evaporation to the Leeward 229
  - Table 230
  - Table 231
  - Table 231
  - Table 232
- Influence of a Clover Field Upon the Rate of Evaporation to the Leeward 232
  - Table 232
- Influence of Woods and Grass Fields Upon the Humidity of the Air to the Leeward of Them........ 233
  - Table 233
- Width of Zone Influenced by Wind-breaks........ 234
- Rate of Evaporation from Water Surfaces........ 236
- Evaporation of Water from Continuously Moist Soil........ 237
- Combined Evaporation from Soil and Crop........ 237
  - Table 238
  - Table 239

The Forest Tree the Savior of the Soil, by Miss Florence Conway.. 241

List of Illustrations.

PAGE

The new driveway through the knob lands of the State Forest Reservation 12
Fish pond and water reservoir 14
New administration building 16
Cultivating young walnut trees 23
A wood pile for buzz sawing 25
Improvement map 26
A hoop-pole factory 34
Black locust growing on the Leavitt forest plantation 36
Catalpa growing on the Senator Parks forest plantation 38
Black locust growing on the Q. A. Myers farm 40
Silver poplar growing untrimmed 46
Silver poplar growing under constant pruning 47
A tree trimmer at his work of destruction 48
A soft maple trimmed to death 49
A result of the systematic trimming of soft maples 50
A soft maple growing untrimmed 51
A poplar tree trimmed for shape 52
A natural shaped poplar 53
A red maple persistently trimmed 54
A bad case of trimming 55- 56
A work of the electric lineman 57
A case of bad trimming 58- 59
Trees trimmed for fear of falling limbs 60- 61
Work of the electric lineman 62- 64
Rock maple, forest grown 66
Rock maple, field grown 67
The size of a tree for planting 68
A row of elms 70
Tulip tree (yellow poplar) 72
Hickory tree, field grown 73
Hickory tree, forest grown 74
Catalpa (speciosa) 76
White oak, field grown 78
Sycamore, grown in the open 80
Tree scales 85
A tree weakened by trimming 90
Black walnut 103
Butternut 104
Shellbark hickory 105
Kingnut hickory 106
Pignut hickory 107
Cottonwood 108
Beech 109
Chestnut 110
Red oak 111

PAGE
Pin oak 112
Black oak 113
White oak 114
Burr oak 115
Rock chestnut oak 116
Chinquapin oak 117
American elm 118
Slippery elm 119
Yellow poplar 120
Sycamore 121
Wild black cherry 122
Honey locust 123
Kentucky coffee tree 124
Black locust 125
Red maple 126
Sugar maple 127
Black sugar maple 128
American linden 129
White ash 130
Black ash 131
Catalpa 132
Entomologist at work 135-136
Stump and sprout 139
Abrasion at base of young growth 140
White oak leaf eaten by leaf miners 141
Work of timber beetles and borers 142
Work of timber worms 143
Work of timber borers in the heartwood 144
Black oak leaf destroyed by leaf eaters 145
Work of hickory beetles and borers 147
Hickory leaf eaten by leaf eaters 148
Flat headed borers in pine wood 150
Nut weevil 153
Egg chambers of the cicada 154
Slug caterpillar and larva 155
The gall fly 158
Cyllene pictus 160
Engraver beetles 162-163
Ichneumon fly 166
Pignut hickory leaf badly eaten by leaf eaters 167
Scarlet oak leaf badly eaten by leaf eaters 168
White oak leaf badly eaten by leaf eaters 169
Large toothed aspen slightly eaten by leaf eaters 170
Hickory leaf injuries 171
Work of leaf rollers 172
Girdling methods 177
Clover and oats in the lee of woods 226
Oats killed by winds 227
Protection of grain from winds by woods 228
The evaporator in field 230

Indiana State Board of Forestry.

OFFICIAL MEMBERS, 1905.

FINLEY C. CARSON, President	Michigan City.
STANLEY COULTER	Lafayette.
LARKIN M. STULTZ	Westfield.
SAMUEL BURKHOLDER	Crawfordsville.
WM. H. FREEMAN, Secretary	Wabash.
ELLA GROW, Stenographer	Indianapolis.

Office of Secretary,

Room 93, State House, Indianapolis.

State of Indiana, Board of Forestry,
Indianapolis, December 1, 1905.

Hon. J. Frank Hanly, *Governor:*

Dear Sir—In accordance with the legal requirement, we have the honor to submit herewith the manuscript of the Fifth Annual Report for the Department of Forestry. It contains papers of discussion and explanation of the work accomplished by the Board in different sections of the State, of the work accomplished at the Forest Reservation and Experimental Station, Clark County, Indiana, and of the field work of the assistants, Messrs. Douglas, Davis and Haltom.

We desire to thank you for your courtesy, ready co-operation and sincere interest in the cause represented by this Department, and assure you it is a work constantly advancing and becoming one of the most important institutions, affecting as it does the whole institutional life of the State.

We have the honor to be, with great respect,

Yours very truly,

F. C. CARSON, President.

W. H. FREEMAN, Secretary.

Financial Statement.

November 1, 1904, to October 31, 1905.

I. ANNUAL APPROPRIATIONS BY ACTS OF GENERAL ASSEMBLY, 1903.

Office:	
Salary of Secretary	$1,800 00
Salary of Stenographer	600 00
Salaries of four Board members, each $100	400 00
Mileage of four Board members	112 86
General office expense	1,000 00
Total	$3,912 86

Forest Reservation and Experimental Station:	
Management	$3,000 00

II. SPECIFIC APPROPRIATIONS BY GENERAL ASSEMBLY, 1905.

For labor and improvement State Forest Reservation and Experimental Station:

Building improvement, northeast	$800 00
Road building	950 00
Reservoir building	250 00
Border line fence building	350 00
Total	$2,350 00

EXPENDITURES.

Office—Salaries:	
W. H. Freeman, Secretary	$1,800 00
Ella Grow, Stenographer	600 00
F. C. Carson, Board member	100 00
Stanley Coulter, Board member	100 00
John Cochrane, Board member	63 00
Albert Lieber, Board member	63 00
Larkin M. Stultz, Board member	37 00
Samuel Burkholder, Board member	37 00
Total	$2,800 00

Office- General Expenses:	
Mileage and livery, W. H. Freeman	$450 64
Mileage of Board members	112 86
Stenographer extra	4 50
Field work	66 50
Photography and supplies	27 68
Postage	304 00
Printing and stationery	74 05
Expressage	37 91
Telephone, rents and tolls	61 25
Total	$1,139 39
Overdrawn and treasurer reimbursed	26 53
Forest Reservation and Experimental Station:	
Management and general expenses	$801 05
Labor	1,888 23
Seeds	310 72
Improvements:	
Road building	950 00
House building, northeast	800 00
Reservoir building	250 00
Border line fencing	350 00
Total	$5,350 00

Preface.

The work attempted and accomplished by the Board for the period of time covered by the herein report was a continuation of the plans as outlined in former reports. Much information of both scientific and practical import was ascertained and given out from time to time through correspondence, visits and lectures to those who made inquiry for forestry knowledge.

There is at this time a strong sentiment favorably inclining to the institution of stronger forestry methods in almost every community within the State. The Board finds on every hand interested men and women of clear conceptions and advanced ideas of the forestry problem and who are rendering assistance by both word and action.

It is a rare instance where an individual of good business judgment, capable of broad discernment and unbiased by selfish motives, is found opposed to the project. Such as they are the most ardent in support of the movement. The cause of forestry will never be opposed or hampered by the strongest thinking men and women of the country, but all danger is to be looked for from individuals who do not understand its importance and will not give it a just consideration, or who by nature born are opposed to any form of evolution. It is from this element of danger that forestry must be guarded in its future advancement. The most dangerous individuals to the general welfare are those who always oppose a thing when they are in doubt as to its importance. Chance for more serious mistakes could not be found than in such a mind. Individuals should never be given preferment in either legislative or councilmanic assemblages who will either approve or oppose a thing until they have a good knowledge of the same.

The Board unqualifiedly acknowledges its obligations to the public-spirited citizens and press throughout the State for the present achievements in forestry, and to them it appeals for a continuance of the interest and manifestations of sympathy shown in the past. The Board is thoroughly impressed with the importance of an intelligent interest in forestry by the people as a foundation upon which to build a permanent State forestry policy.

STATE BOARD OF FORESTRY.

Report of Improvements, Experiments and Conditions

AT THE INDIANA STATE FOREST RESERVATION, FORESTRY EXPERIMENTAL STATION AND STATE NURSERIES AT HENRYVILLE, CLARK COUNTY, INDIANA, TO DECEMBER 1, 1905.

IMPROVEMENTS.

The improvements conducted during the past summer, and which for the greater part were not entirely completed, were the construction of driveways, reservoirs, cisterns, fish ponds, the building of the new administration and headquarters building, the construction of the border-line fences, cultivating the forest area and well-digging. All of these improvements were carried forward in completion as far as the sums approprated would enable, and it is hoped that the efforts of next season will see them fully completed.

Driveways.—The last General Assembly appropriated $950.00 with which to construct a main driveway three and one-half miles in length and extending from the public highway on the east angular through the central sections of the Reservation to connect the new and old headquarters buildings, and to afford a better ascent to the knob lands for the convenience of travel and view of the forestry operations, and to remove the product to market.

This driveway, as shown by the improvement map herein, was for the greater distance constructed entirely new, but for the other distance followed the course of existing driveways, and general remodeling and improvement were only necessary to make them into fairly good roads. More than 50 rods of the knob part of the driveway, however, was a herculean task and was constructed with much difficulty and expense, but none who have viewed it have given an estimate within reach of double the actual cost. Beginning at the point indicated by "Y" in the "improvement map" and continuing to the old headquarters building, indicated by the square containing "III" the ascent was 350 feet in the gradual scale shown by the figures of elevation on the map. For more than half the distance of the ascent, blasting of the knob and sandstone was necessary, thus making the progress slow and expensive. All efforts were successful, and the result is one of the best knob roads to be found in the country of knob lands, and it affords easy ascent and descent at an angle of 17 per cent., as compared to 33 per cent. by the old driveway indicated by "Z" and the square containing "III." This new road is located on the south slope and is therefore not subjected to continued ice-covering during the winter season, as is the case of the old driveway, which is located on the north slope, and because of which it was impassable for the greater part of the winter season, and thus made necessary the new road, both for the transporting of the timber product and the travel of the Reservation.

The new driveway, especially the knob part, was not given its completing touches and will not until after it has received the

No. 2. The new driveway through the knob lands of the State Forest Reservation.

benefits that will come to it by reason of the winter's freezings and thawings, wherein nature will perform a vast labor, which, if done by human hands, would take a great amount of time and money. Another season, however, will see the completion of this task and its benefit will be eminent.

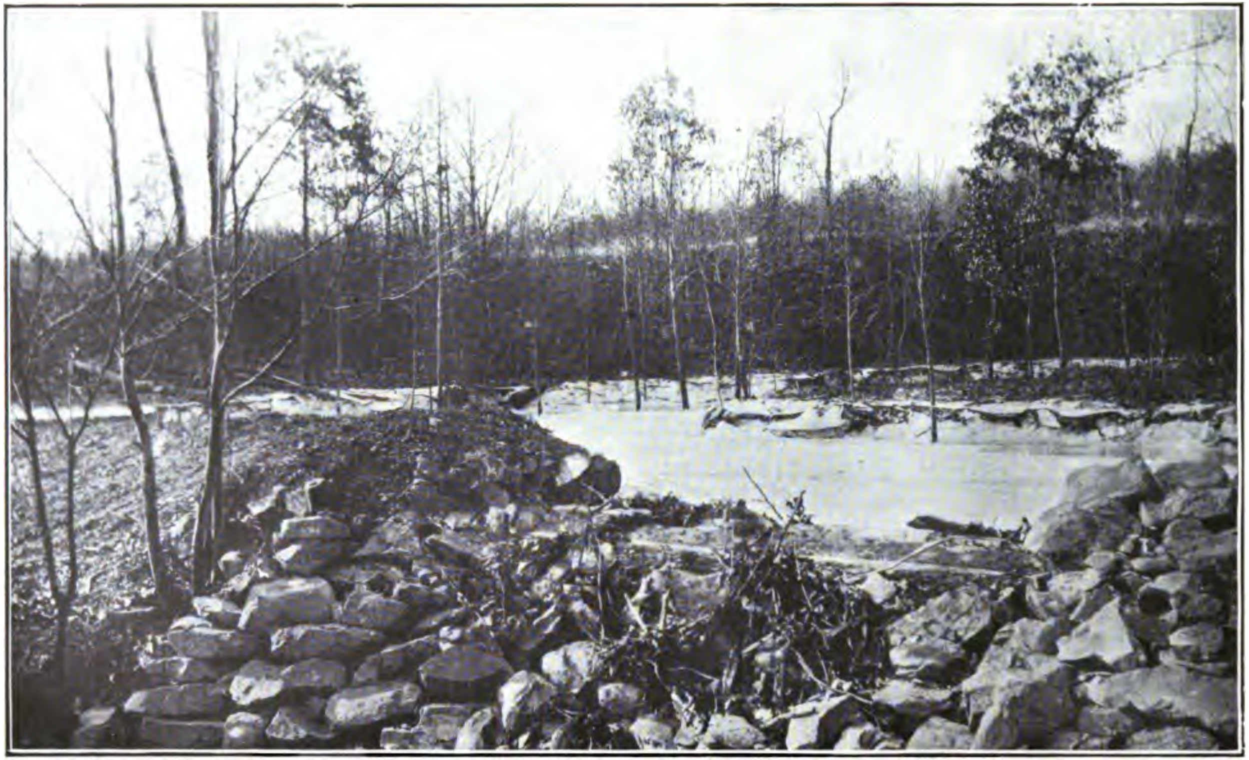
In addition to this main driveway another was constructed extending from "Y" in the "improvement map" to "D". For a portion of this drive the public highway was followed, and which is also the route of rural free delivery for the Henryville postoffice, and thus brings the mail for the Reservation near headquarters.

In all road construction wherever culverts were necessary strong sewer tile were used and stone abutments constructed, and the grading and construction throughout were under the supervision of a civil engineer.

It is the intention of the Board to act in conjunction with the township trustee, Mr. Thomas Dunlevy, in closing the public highway indicated by the dotted line and "C" in the "improvement map," as the same is a menace to the Reservation, and the township will thus be rid of the time and expense required to maintain the same as a public highway. Besides, the fewer the public thoroughfares can be made extending through the Reservation the less danger of depredation both to the forests and game. For the same reasons many of the sub-driveways, indicated by "K" in map, will be closed to travel, but retained only as fire lines.

Reservoirs.—The last General Assembly appropriated the sum of $250.00 for the construction of five reservoirs for a water supply to benefit the game and general animal life on the Reservation as the principal aim and as a secondary consideration to supply water for irrigation and for fire defense in time of drouth, as it must be borne in mind that this particular section of the country is more or less subject to drouth, and the extreme aridity of the summer of 1904 indicated the necessity for reservoir construction in the interest of the things enumerated. Since there are no constant streams flowing through the Reservation, therefore, constant water supply must be obtained by artificial means.

The places for the construction of these reservoirs are indicated by No. 1, No. 2 and No. 3, and work was begun on the first of these soon after August 1st, but contrary to last season an overabundance of rain has prevented the completion of this work. A



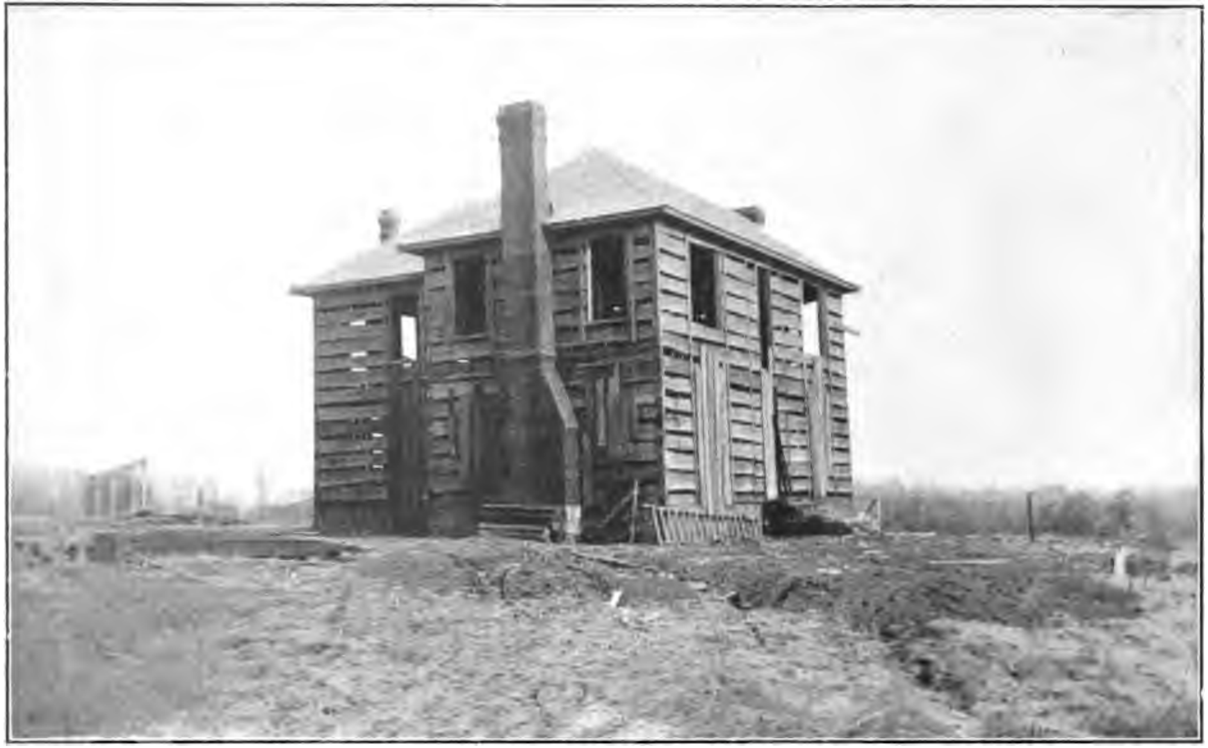
No. 3. A view of the Forest Reservation fish pond and water reservoir.

dam was constructed across the intermittent stream and the digging out of the five connected bayous at different points along the streams for a distance of about 22 rods was partly completed when rain fell to such extent, and has repeatedly done so during the summer and fall, as to prevent any further operations on the reservoir construction.

By a civil engineering plan, a dam 6 feet 8 inches in height and 30 feet long at the first point will back water to a distance of 22 rods, and thus form a body of water consisting in extent of the main stream and five bayou reservoirs or a total area of about two acres. At the second point a similar dam 4 feet 6 inches high and 34 feet long will perform a like result. At the third point a dam 8 feet high and 48 feet long will form a solid lake of about four acres. The sum appropriated will by no means perform this work, but, added to an expenditure from the general fund, it has helped considerable, and it is thought these plans of reservoir construction can be completed next season. When these projects are completed and well stocked with fish of the best pond species, and which the State Fish and Game Commissioner has assured he will do, they will be valuable adjuncts to the Forest Reservation, not in actual dollars and cents, but in the moral spirit of the institution and the fostering of game animals and birds which seek the Reservation for protection and consequently propagate thereon, and by this plan will not be forced to migrate for water and thus fall prey to the lawless hunter.

The two items of expense in this reservoir construction are labor and cement, as timber, stone and gravel are afforded on the Reservation.

Administration Building.—The last General Assembly appropriated the sum of $800.00 for building improvements at the northeast part of the Reservation. At the time this appropriation was solicited by the Board it was thought that such a sum expended to remodel the old buildings located at that part of the tract would make them sufficient for the new headquarters and administration buildings, as the business management of the institution required a place more closely located to the railroad station and postoffice. When the work of remodeling began it was found that by intelligent investigation and estimate that the buildings were in such condition that remodeling would cost more than new buildings,



No. 4 The new administration building now under construction on the State Forest Reservation.

and that the old ones would within a course of a few years without doubt have to be replaced by new and other buildings, consequently remodeling was abandoned and a new set of administration buildings was put under construction and the old buildings razed, and such good material as they possessed will be used in the new structures.

In keeping with the institution, its aims and conditions, the new administration building is constructed of logs taken from the forest of the Reservation and nicely hewn and put up in the most skillful manner and under the supervision of as good a mechanic as the country afforded. The structure is 40 feet by 20 feet for the main part and 20 feet by 20 feet for the secondary part, and is two stories high. It is hip-roofed, and will be finished in pioneer style within—simply chinked and daubed in a splendid manner, and left in natural wood style as to walls and ceiling structures. Fireplaces are built and will be used in heating the building. Cellar, cistern and other modern conveniences will be constructed for the convenience of the occupant, and it is intended such a person shall be an expert forester, nurseryman and general overseer for the institution.

The new structure is under roof and is left to thoroughly season and settle over the winter season before final completion next spring and summer. This feature of the improvements conducted is the admiration of all visitors to the institution, and when considered in the light of the past and the future, and in connection with the institutional aims, is unique and fitting as well as serviceable, and but small if any more expensive in construction. It, in connection with the driveway and reservoir improvement, adds aesthetic force to institutional form, and let it be distinctly understood that the Forest Reservation is an institution. As was remarked by a member of the Legislative Investigating Committee while visiting it, that it was far more than he had ever thought it to be and that it must be classed under the real institutions of the State.

The old headquarters building will be retained and occupied by the patrolman and game warden employed for the protection of the Reservation against trespass and fire damage, which are necessary things to be guarded against in that locality.

Fence Building.—The sum of $350.00 was appropriated by the last Legislature with which to construct the one-half of a border-line fence between the Forest Reservation and adjoining land-owners. Written agreements were entered into by and between the adjoining landowners and the Secretary of the Board to the extent of 1,363 rods of fence construction, and the same is now under way and will be fully completed by May 1, 1906, which is the limit of time given for the completion of the same. The owners of land joining the Reservation have agreed to build the fence as per contract specifications drawn by the Secretary of the Board, the Board to furnish the material, and the Board has done the same, securing the chestnut posts from the forests of the Reservation, and by purchasing 26-inch woven wire for the bottom part and galvanized barbed wire for the upper part of the fence. Thus the fence will be a 26-inch woven wire bottom, to keep out sheep and hogs, and two strands of barbed wire above to turn cattle and horses. Seventeen bids were received for supplying the wire fencing material and the contract was awarded the firm of Raymond & Scholl, Henryville, Indiana, dealers in the "Pittsburgh Perfect Patent" woven wire fencing, for supplying all the material, as they were the lowest bidders. The fence posts were secured by the labor employed on the Reservation. The distribution of the material along the lines of construction, clearing out of the lines, and the proper construction of the fence shall be by the adjoining owners of land, but under the direction and supervision of the overseer of the Reservation. Material for 1,400 rods of fence was purchased by the Board, as that much will be needed to complete the work.

Miscellaneous.—In addition to the extensive improvements enumerated, some minor advancements were made. A cistern of about 80-barrel capacity was constructed at the barn on Grandview Knob for a supply of water for the use of the Reservation teams and horses and for the accommodation of the teams of visitors at the headquarters, of which the number the past summer and fall far exceeded that of last year. It was found necessary to do this in order to cope with conditions such as was encountered last season should the locality again suffer such an extensive drouth. This cistern was walled up in a first-class manner with brick and cement and supplied with a good wooden pump. The barn was spouted for conducting water into the cistern. The expense of this improvement was very nominal.

Two water wells were also put down on the Reservation, one at the new administration building and one at the place where next season building improvements are to be made for the tenant and teamsters' residence in the south-central part of the Reservation, indicated by the square and "II" in the "improvement map." This second well was put down at this time because it would have to be done in the future and could be performed in conjunction with the other well at a much less expense than if delayed and caused the return of the machinery at another time, since there are no well-digging machines in the locality. These wells were 8-inch driven, piped down to the stone and supplied with brass-lined cylinder force pumps, and cost $1.25 per foot. One well was 122 feet and another was 72 feet. The first well was a failure at the administration building, and it was necessary to put down a second one there.

SEED PLANTING, 1904.

The seeds which were planted during the fall season of 1904 for the larger part came and grew well the past season. But one exception is noted, and that occurs in the fields first planted, where the seeds, as acorns and chestnuts, owing to the fine growing condition of the weather which charactertized the greater part of last November, sprouted so extensively that many were killed by the hard freezings of last winter. In these fields transplanting will be necessary the coming spring. This incident warns against too early planting in the fall, as forest seeds such as those given germinate upon the slightest growing weather provocation.

As shown by last year's report, about 100 acres of field lands were regularly planted with various species of forest seeds in mixture and about 15 acres of nursery thickly planted in addition. It may be said that as a whole most of the seeds planted came and grew well considering the small amount of cultivation given them during the summer, but nothing like the results were obtained that would have occurred under the proper care. (See topic "Tree Cultivation.")

The rodents worked havoc in all the fields bordered by woodlands, especially the parts next to the woodlands. Persons not familiar with the depredations can scarcely be made to believe the extent of such damage. There are, however, thousands of young seedlings of all the best commercial species of the oaks, besides American chestnut, black locust, Kentucky coffee tree, American ash, Texas pecan, English walnut, wild cherry, and catalpa speciosa, growing in the nursery which in the course of another year or so will be large enough to begin transplanting in such places as vacancies occur in seed growth. Seeds of all kinds are also being put in storage to be used in transplanting next spring.

SEED PLANTING, 1905.

Seeds of the white, red, burr and chestnut oaks, American chestnut, black walnut, small and large shellbark hickories, buckeye, sugar maple, sycamore, hackberry, catalpa speciosa, red cedar, sweet gum, and black locust were secured for both field and nursery planting this fall and next spring. The following approximated acres of planting were performed this fall up to date of this report:

Twelve acres to white, red, burr and chestnut oaks, American chestnut, the hickories and black walnut—soil mixed porous sandy and hard clays of 620 feet average elevation.

Fifteen acres to white and chestnut oaks, American chestnut and hickories—soil hard soapstone clay of 650 feet average elevation.

Six acres to black walnut, chestnut oak and American chestnut—soil sandy, porous clay of 600 feet average elevation.

Eight acres to black walnut, chestnut, burr and red oaks, American chestnut and the hickories—soil low and high, sandy, porous and hard clays of 650 feet average elevation.

Fifteen acres to black walnut—soil sandy, porous clay of 520 feet average elevation.

Seven acres to hickories, chestnut and chestnut oak—soil hard clay of 590 feet average elevation.

Three acres to buckeye, red and burr oaks—soil rich bottom clay of 560 feet average elevation.

Five acres to all kinds of seeds, excepting the hickories and walnut, thickly drilled for nursery stock—soil rich, sandy, porous clay of 580 feet average elevation.

These plantings, except the nursery, were regularly made at distances of five feet apart each way and for the greater part the mixtures of species were made by planting alternately the different species by rows. In some instances the species were planted in blocks, the same being determined by the adaptability of the soil and the seed. All the ground was well prepared and crossed off systematically for planting, so that cultivation can be performed both ways.

Not all the fields planned for planting this fall can be gone over, as the abundance of rain has prevented their being prepared owing to the softness of the ground. The seeds on hand and in shipment will be stored until spring, when it is expected to continue the plantings.

SEEDLING TRANSPLANTING.

No seedling transplanting of any magnitude has yet been done. The means at the Board's command did not permit of any extensive purchase of trees and the time has been too short in which to grow seedlings in the nurseries to sizes sufficient for such work, though, as stated above, seedlings by the thousands in the nursery are now nearing the size and age for transplanting, and when they are suitable for this feature of the work then the same will be extensively conducted over all parts of the Reservation, but especially upon knob lands, where seed planting is impractical because of the rodentia.

The 10,000 small white pine seedlings which were secured from Sturgeon Bay, Wisconsin, and transplanted upon the knob lands in the early spring of 1904, most all perished in the excessive drouth of that summer. It is doubtful if any living seedling could be found. (An attempt is being made to grow white pine in nursery at the Reservation. At this time it seems that fairly good results can be secured by slatting the nursery beds to break the sun's rays from the small plants.)

The 200 shade and ornamental trees of large size planted upon the premises at headquarters Arbor Day, 1904, by the pupils of the public schools of Monroe and adjoining townships grew well the past season. Of the 100 nursery-grown transplanted trees secured, all but six lived. Of the 100 forest-grown trees secured and planted at the same time, and which were of large sizes, about 60 per cent. failed to grow. This per cent. of failure may be attributed to two or more causes. The trees were secured from low lands in the same community and transplanted on highlands. They were perhaps of six or eight years' growth, and it is seldom a tree from the forest at that age, and which has not been transplanted, can be made to live. It may be that the trees were stunned by the excessive dryness of the summer prior to the digging for transplanting, and the shock of digging and transplanting completed the destruction of life in them. The lesson taught, however, is that it is a poor plan to dig and transplant overgrown trees from the forest and expect them to live and do well. Where good-sized trees are wanted for planting it is a saving of time and money to buy nursery-grown transplanted trees.

TREE CULTIVATION.

Only a small amount of cultivation could be given the trees growing in the planted fields this past season, and about 15 acres had to be abandoned entirely to the ravages of the weeds because of the lack of funds with which to do the work of cultivation. The entire planted area was greatly hindered in progress of growth because no funds were available to give the trees the cultivation needed, and consequently the rank weed growth almost smothered them out. The following is the explanation for this condition of things: The general appropriation of $3,000 annually was only such a sum as could be asked for at the time the bill was framed for enactment into a law for the purchase of the Reservation, as no one knew anything of where the site would be selected, its condition or its needs. The aim on the part of the Board was to ask only such a nominal sum as would enable them to conduct the institution until its needs could be ascertained and then the following General Assemblies would be asked for such specific appropriations as needed from time to time to rightfully conduct the work, equip and improve the same into an institution of State merit. Hence, in order to accomplish the most in time the funds were expended in planting the fields with the idea that the funds needed for cultivation would be specifically appropriated by the last General Assembly. The Board submitted its needs to the members of the Legislative Investigating Committee, who, upon investigation, recommended to the Ways and Means Committee

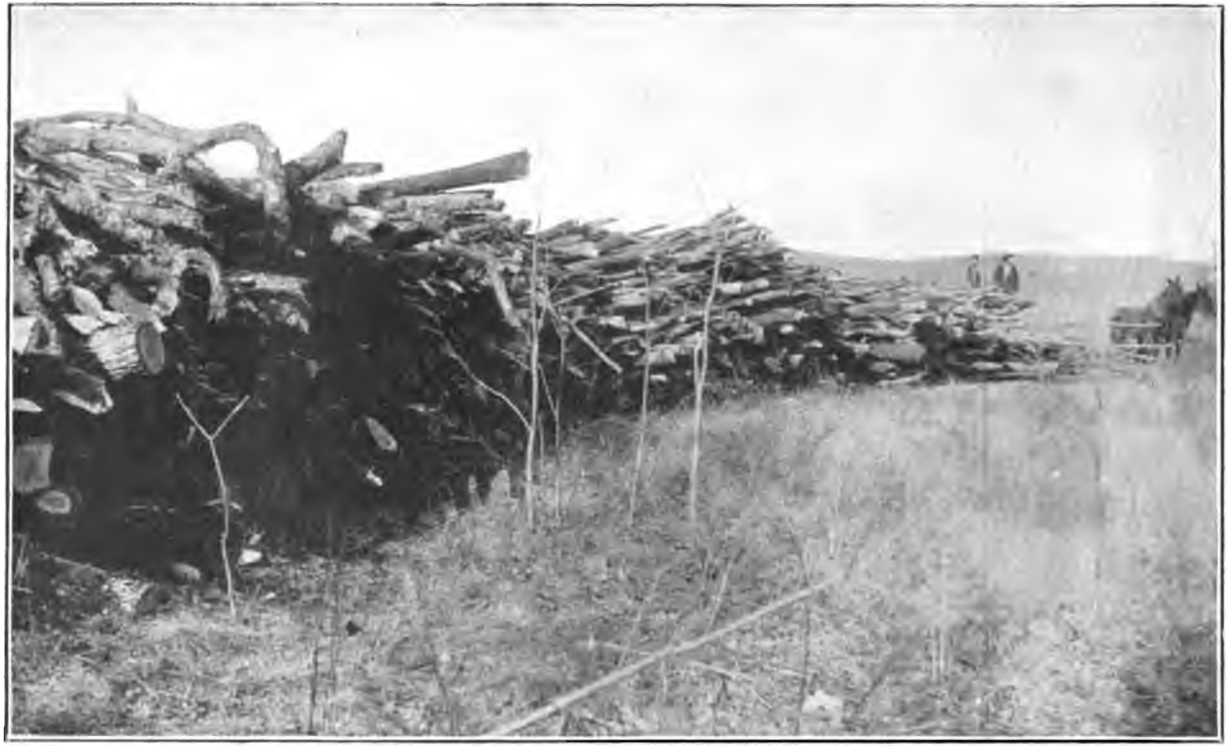
No. 5. Cultivating young walnut trees on the Forest Reservation.

that the several amounts be allowed. The sum of $1,800 was asked for to be used for the specific purpose of cultivating the planted fields and to be divided equally between the two seasons, the one just past and that of next year. Thus $900 per year was asked with which to cultivate the fields as they would be planted from season to season as extensively as the same could be accomplished. From some unknown cause, but over the protest and explanation of those informed concerning the need, the amount, though allowed, was made available November 1, 1905, instead of May 1st, as was asked. Thus the money needed to save and promote the work of the previous year was made available after the season for work was past. With the amount available for the next two seasons the Board expects to accomplish some good work in growing trees upon the open fields if anything like ordinary climatic conditions prevail.

FOREST CULTIVATION.

The work of cultivating the afforested parts of the Reservation was carried forward as rapidly as the other lines of improvement work would permit for the period of time from August to the middle of October, at which time seed gathering and planting ocupied the entire time with few exceptions. The work done this autumn and fall is the most satisfactory of any former attempts. Under the foremanship of Mr. James Soliday the work was complete in every detail. All inferior and excess trees of every kind were cut out and converted either into dimension material, lumber, railroad ties or fuel. The product has not been put upon the market because other work has occupied the teams constantly. The entire time from December to April will be devoted to cleaning up the woodlands as they should be to form a future permanent timber stand to grow into larger commercial trees and to placing the product upon the market. Good contracts have been secured for almost all the stuff which may be cut from the forests, and it is thought without hesitation that satisfactory results will follow the efforts.

Nearly 100 acres were thus completely cultivated this autumn and fall and a great amount of cutting out done at various points over the Reservation in getting out the timbers for the different



No. 6. A pile of poles for wood sawing on the Forest Reservation obtained from cleaning up the woodland.

improvements. The last General Assembly appropriated $3,600, the one-half of which became available November 1st and the other half will be available next November. In asking for this appropriation it was argued that sufficient product could be placed upon the market with this sum to reimburse the State in full and thus leave the woodlands in the proper condition for maturing at no outlay. The amount will not near cover the area thought, under the complete cultivation, which is given, but the quantity of material will be so much greater than expected that consequently the plan will not fall short in the reimbursement feature.

N.

the
han
t is
ex-
sti-
ake
on-
the
ing
itu-
All
ral
ect
od,
it
no
tal
ral
l is
ken
out
vas
ch
the
vas
nd
in

the
ne,

impr
the or
half
priati
the m
leave
outlay
the co
terial
plan

Some Facts for Thinkers.

THE PURPOSE AND AIMS OF THE FOREST RESERVATION.

Doubtless there is not an institution within the borders of the State but what is better understood in its aims and purposes than is the State Forest Reservation and Experimental Station. It is also very doubtful if there could be any more vague opinions expressed than are commonly uttered as to the outcome of the institution from the points of financial returns and the time it will take to produce timber of commercial size. The views sometimes honestly expressed as to what should be done at the institution in the way of timber-growing and the handling of the existing young trees are as far from the aims and purposes for which the institution was established as the range of intelligence will permit. All these vague and indefinite conceptions in the minds of the general citizenship directed the Board's policy in presenting the subject of forestry to the public. It thus sought the object lesson method, as against the unconvincing theoretical teaching, even though it takes a much longer time. In such a long-lived industry time is no object if certainty is acquired, and thus the Forestry Experimental Station was sought and obtained at the hands of the General Assembly of the State. In its operations the absolute practical is given predominance over the scientific features. Poor broken land was selected for the site of the Station because, without doubt, extensive forestry will be confined to such lands, and it was the aim to make the State demonstrations upon a type of such lands, of which there are more than 600,000 acres located in the southern half of the State. The site at Henryville, Indiana, was chosen because it was the best possible type both as to location and character of land offered, and there is no question of its fitness in view of all the aims, purposes and conditions.

In almost every common discussion of the Forestry Station the one element which seems to be uppermost in the minds of some, and who are of high esteem among their fellow men, is, How much money can the State get out of it? It frequently occurs, that at the end of a tour with visitors in which the thrifty-growing young hardwood trees are pointed out as the richest opportunity for the demonstration of practical forestry and from which to develop, how long it will take for second growth trees to mature to commercial value, a party will say, "Can't you sell them for something now and get some money out of them? Why, it will take a thousand years before they become big trees." Money is the one small feature to be considered in the purpose of the institution. The investment is no doubt a splendid one, as later facts will show, but the primary and paramount aim is the object lessons in practical forestry upon the cheap lands for the edification of the people of the State that timber-growing may be intelligently performed thereon and thus lands now abandoned may be reclaimed to value, and the timber needed for the industrial welfare of the State augmented by replenishment in so far as such lands can do it. The dollars-and-cents estimate should no more be reckoned on this institution than it should upon any and all of the other educational, charitable or benevolent institutions belonging to the State and maintained by them for the uplifting and education of mankind. It is that greed for gold which has robbed the State of Indiana of its former unexcelled forests. The aim is higher than financial profit, it is intellectual and spiritual upbuilding.

THE LAND INVESTMENT VALUE OF THE INSTITUTION.

The Forest Reservation and Experimental Station from the consideration of land investment is surely good, as can be judged from the increased value of adjoining lands since its establishment. This tract of 2,000 acres was bought at an average price of $8.00 per acre. It at this time could not be bought for double the amount and it can be sold for more than double the sum paid now if placed upon the market. These are not mere assertions without foundation. The land prices there at this time are at high tide and the advance in the future will be slower than in the last few years, but a decided slump in real estate will have to occur before the present values will be lowered. In view of the present general real estate conditions and the progress of the country generally it is safe to say the time is not capable of prediction when the State will fail to get value received for every dollar invested even as a land-deal transaction.

THE FOREST VALUE OF THE INSTITUTION.

This feature of the Reservation is more difficult to determine than the land value. It will be just as easy, however, to actually underestimate as to overestimate this worth. The rate of increment per acre or tree and the advance of price for lumber in the market are things which can not be foretold with any degree of accuracy. Therefore, any conclusions given will have to be mere approximations and based upon common intelligence and observation. The following are some facts actually known:

I. One thousand two hundred acres of natural second-growth forest now standing. Thirty-three average places were selected and accurate counts made of the prime trees per acre, which showed of white, chestnut, scarlet, black and pin oaks 343 trees per acre ranging in size from 1 to 15 inches. Other counts made for particular trees showed the following stand per acre: White oak, 23 counts, 143; chestnut oak, 20 counts, 157; scarlet oak, 21 counts, 108; black oak, 20 counts, 55; American chestnut, 9 counts, 60; hickory, 12 counts, 163; sugar maple, 3 counts, 163; red maple, 13 counts, 40. Besides these there are plenty of beech, gum, sassafras, sycamore and quite a few ash and birch. The counts were made at various places over the tract, and the same conditions prevail throughout with a few exceptions upon the knob lands and slopes, where white pine exists in goodly quantities but underneath is a splendid stand of hardwoods.

II. There are planted in 200 acres of open fields and growing at regular distances of 4 and 5 feet apart the following approximate numbers and kinds of standard hardwood trees: Black walnut, 50,000; American chestnut, 40,000; hickory, 25,000; oaks, 75,000. This number of acres regularly planted should contain, at the distances given, 300,000 trees, but I am allowing for approximately 75,000 vacancies to be transplanted, and the remainder, 35,000, is of wild black cherry and American ash, of which two plantings no definite data was obtained. There are yet about 300 acres which can be regularly planted and about 100 acres which will have to be irregularly planted. When the intended planting is all accomplished and the same is placed at the standard of expectation the following will be the growing-tree consideration, counting the existing forest area at the low average of 300 standard growing trees per acre of the sizes given above in the discussion of that feature:

1,200x300=	360,000
500x1,500=	750,000
Total	1,110,000 trees.

The afforested area, after complete cultivation, should and will, contain at least 200 thrifty, uninjured trees of from 1 to 12 inches in diameter and of only the best commercial kinds. Under any ordinary circumstances and conditions at the end of 25 years there should be 100 or more merchantable trees per acre, as with the start now attained that number of years will afford a splendid growth, in fact beyond the comprehension of those not familiar with tree growth for such a period, and who base their assertions of the time it takes an oak or hickory to grow into merchantable size upon the large virgin trees suitable for large quartered product. I am unable to state just what might be counted a good estimate, but suppose the range in value per tree to be from $1.00 to $5.00, and $10.00 might not be out of the way. Thus 1,200 × 100 × $1.00 = $120,000. At $5.00, the value would be $600,000. The value in 50 years should and would be three times as much.

The planted area should at the end of 25 years possess at least 500 to 800 good trees, both in size and quality, per acre. At 50 years there should be from 250 to 400 trees per acre. At the end of 50 years there should be growing upon the 400 acres regularly planted fields at least 100,000 good large commercial trees, especially the walnut, chestnut, ash, cherry and most of the oaks. The white oak and hickory will not be so large as the others, but they too should attain a size of 15 or 20 inches in diameter in such a period of time, but the walnut ought to be much greater, and so ought the American chestnut, wild black cherry, ash, and the other oaks. And because of the dense planting and thinning the boles ought to be long and straight, and consequently of the greatest commercial value. The estimate of value under even the ordinary advancing prices of the next 50 years for lumber ought to be not less than $5.00 per tree, and the average of $15.00 or $25.00 might not be out of all reason. Thus 100,000 × $5.00 = $500,000. At $15.00, the value would be $1,500,000.

Thus at the end of 50 years there is a possibility that the minimum forest value of the 2,000 acres will be $860,000; the average possibility of $3,300,000; and the maximum possibility of $6,100,000.

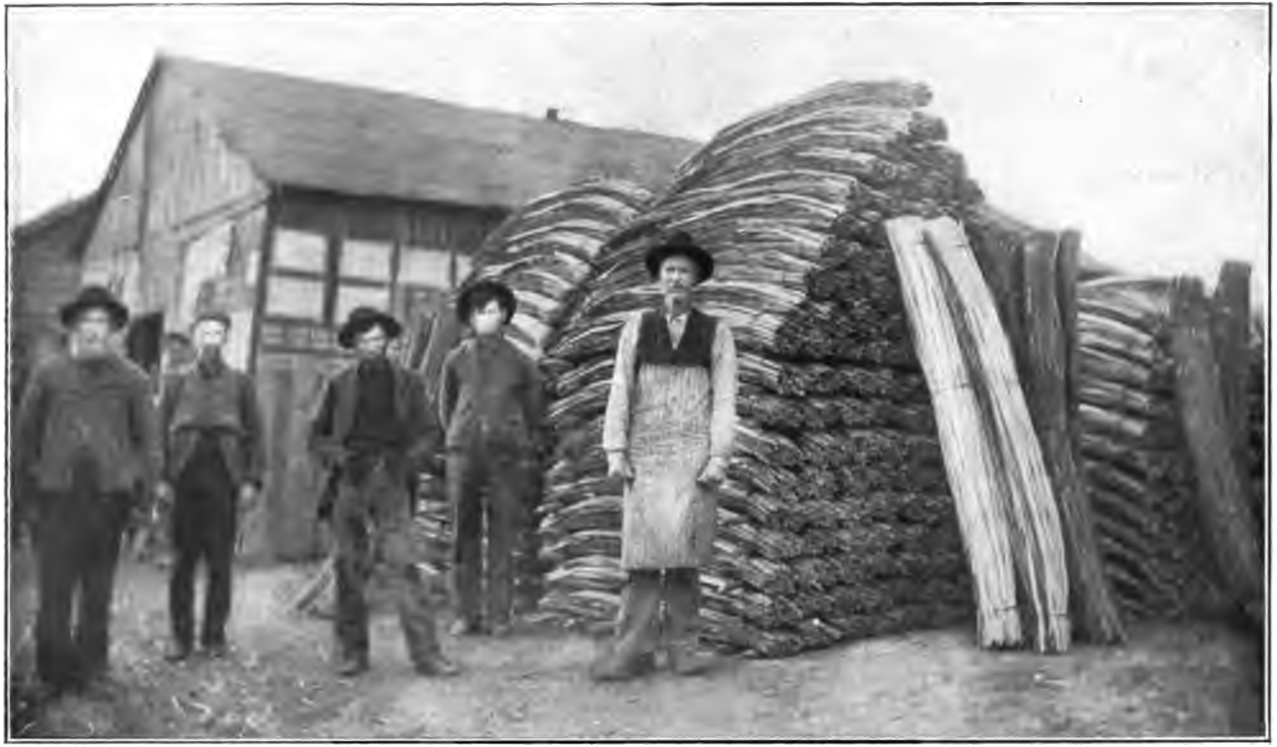
These estimates may appeal to readers as the embodiment of both the sublime and the ludicrous, but who can truthfully say there is nothing in the proposition? If any individual can give an accurate estimate containing the reasonableness accorded in the above the writer will be glad to give it the fullest consideration. The facts here stated and the ideal conclusions drawn are to portray to those having only financial optics that the Forest Reservation, even in the minor consideration which they accord it, is a good thing.

The idea is sometimes advanced that the character of soil such as the Reservation possesses will not grow trees rapidly and of large size. Such assertions are mere opinions and not founded on facts. The rate of tree growth on such soil is greater than that found on the richer agricultural lands, but it may be that the trees will mature on such soils before they attain the size common to trees in the Wabash Valley. The past history of the section as to its forest trees is that the same was one of the most densely forested regions within the State. Hickory, ash, poplar, walnut, sycamore and all the trees common to Indiana were found in an early day unexcelled in size by those of any other region. Today may be found standing in all parts of the vicinity as large oaks and poplars as seen anywhere in the State, but like all sections the large timber has been cut and sold. This fact is more true in the locality of the Reservation than elsewhere because farming has been the secondary occupation and timber cutting and marketing the prime industry for all time since the settlement and permanent occupation of the land began in that part of the State.

THE FINANCIAL INVESTMENT AND INTEREST.

As has been stated before the money invested in the 2,000 acres as a real estate transaction is $16,000. The State appropriates annually $3,000 with which to manage and perform the various kinds of work thereon in the advancement of the forestry features to the extent as such a sum will go. Sundry amounts have been specifically appropriated, as shown by the financial statement in this report, to improve the lands and forest area and place the same in such an organized condition as will make it stand out as a State institution of merit and recognition. The aggregate of such allowance is $10,190, divided between the coming two years. Of this amount $3,600 is for the cultivation of the afforested area and putting upon the market such material as is taken off in doing this work. The money received from the sale of the same to be returned to the State Treasurer to be placed in the general funds of the State. It is thought, and rightly, too, so far as can now be perceived, that the sum expended in the forest improvement will result in a return to the State of a sum equal to the amount expended at least, and consequently can not be figured in the total of the amount invested in the institution.

The amounts so far appropriated will not equip, improve and organize the institution as it should be to make it the most valuable and influential in its aims and purposes. All persons are not afflicted with financial jaundice and want an institution conducted in any manner just so it returns a profit of money. The Forest Reservation and Experimental Station is a State concern and must therefore be improved to meet the expectations of ideal citizenship in such matters. The individual who will stand out against any intelligent improvement of this land to meet the ideas of the up-to-date citizen of Indiana is no more nor no less than the same citizen who will wail against any and all modern improvements whether of municipal or private concern. This institution, though conducted upon the highest plane of forestry technique, if not improved and organized in a business manner, will fail to have the best results upon its observers. Splendid State park features added to the institution will not hinder its aims and purposes in the least, but on the contrary would advance the influence a hundredfold. The model man of any community, be he a merchant, lawyer, doctor or farmer, is the individual who keeps alive to the civic advancements of the day, and whose hand and voice are uplifted in their behalf. The rightful improvement of the Forestry Institution should be carried forward until such attractions are added as will, with the forestry work being done, attract both esthetically and intellectually. It must also be borne in mind that it is not an 80-acre farm sought to be improved and conducted, but 25 such tracts, and consequently proportionate appropriations must be made.



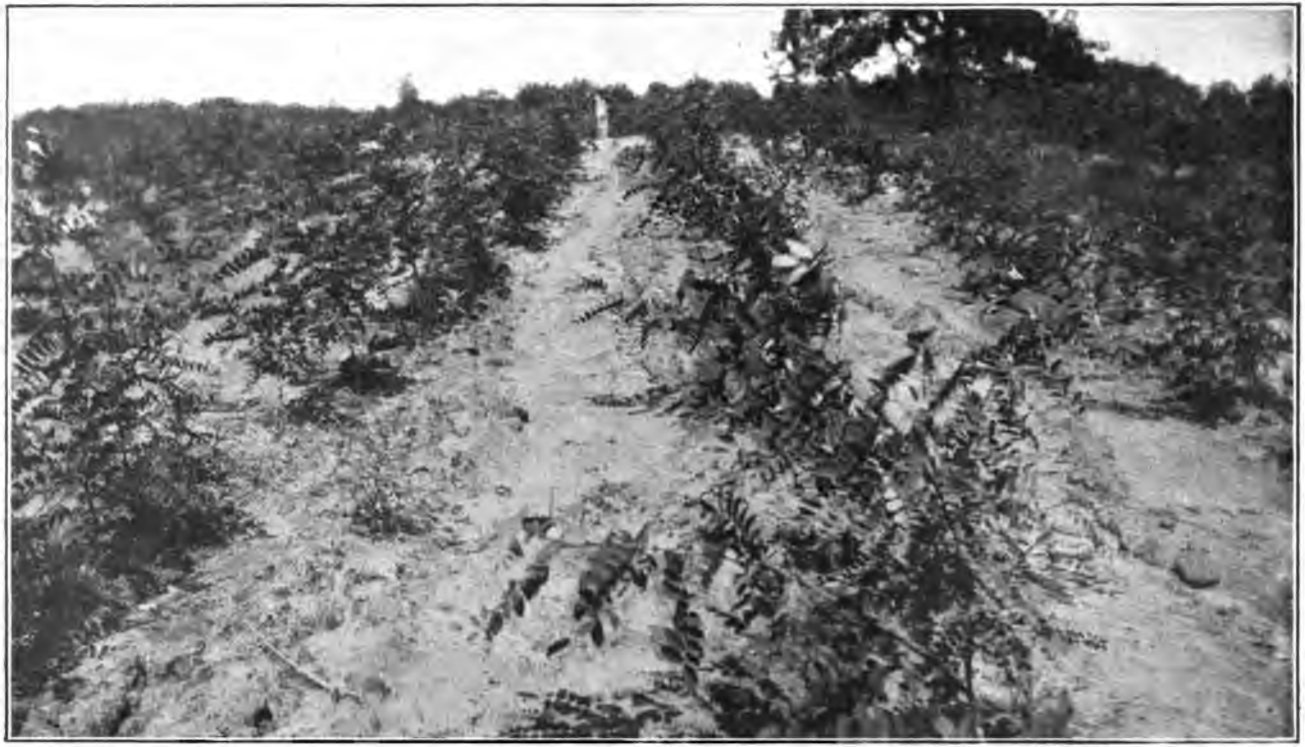
No. 10. A hoop-pole factory near the Forest Reservation.

Report of the Office Work.

PLANTING, INSPECTIONS AND RECOMMENDATIONS FOR PRIVATE INDIVIDUALS AND CORPORATIONS, AND GENERAL FORESTRY ADVANCEMENT.

The work accomplished in forestry the past year was of a similar nature as that of the previous one. A great amount of correspondence was conducted by the office in the attempt to stimulate interest among the people and in answer to inquiries relative to forest planting and general tree culture. Visits and inspections were made for individual and corporation forestry work and written plans and instructions rendered in all cases. In so far as the office was able, visits to all growing plantings of previous years were made and suggestions and directions given for their advancement, but the number of these are too large for an inspection of them all. A great amount of correspondence was done in this connection.

The same plans and features of agitation were continued as in former years, addresses before farmers' institutes, educational and other public gatherings and by mailing out the official reports, and Arbor Day Annuals, and other forestry publications by co-operation with the United States Forestry Department. The field work of the office was delegated to assistants, under the direction of the Secretary, this summer, because the Secretary of the Board took personal supervision of the Forest Reservation and Experimental Station in Clark County, and, therefore, could not do the field work. From three to five days of each week were devoted by him to overseeing the work of improvement and forest cultivation conducted there from April 1st to November 1st. The reports of the field assistants herein published will show for themselves as to the character of the work done. In every consideration it is believed the work of forestry is rapidly and permanently advancing and it only remains for sufficient time to elapse in which to permit evident developments.



No. 9. A view of the black locust planting on the Leavitt Forestry estate. Vernon. Ind.

INSTRUCTIONS AND RECOMMENDATIONS.

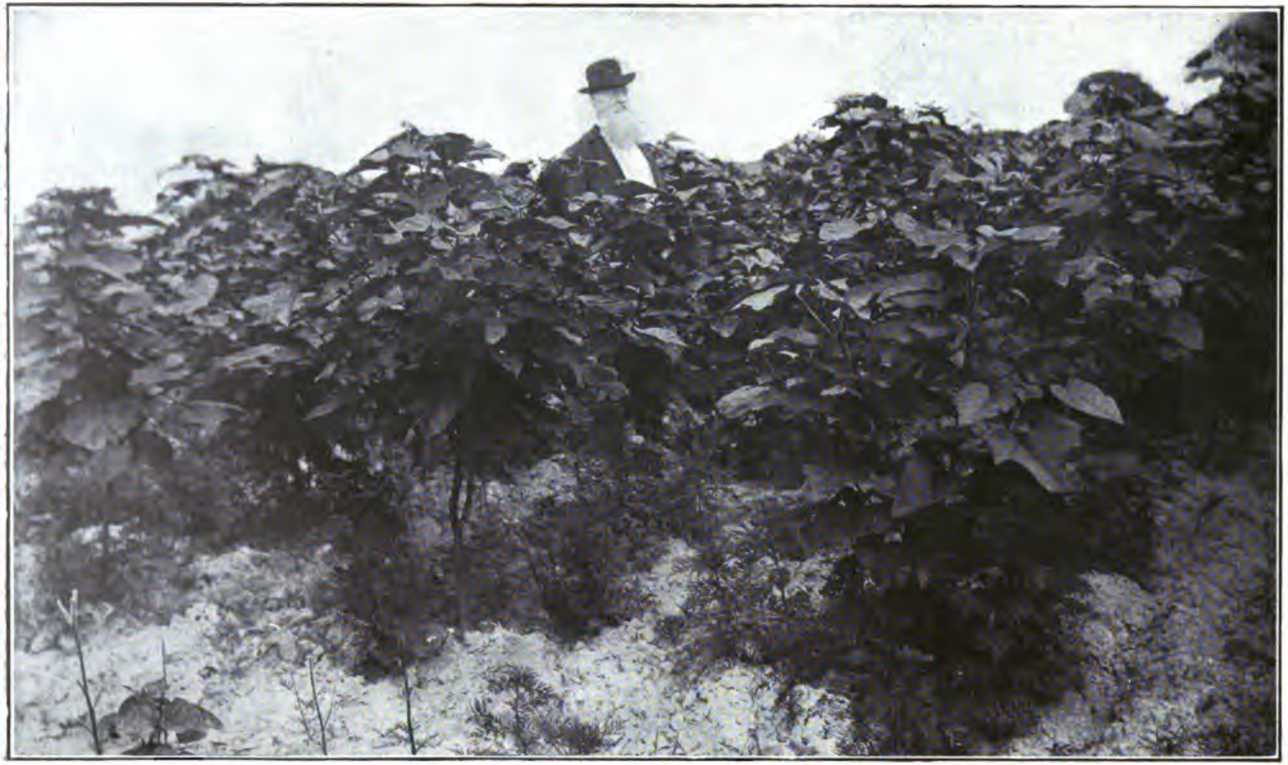
The number of instructions and recommendations rendered for planting the past year was not so large, but of good character, and indicate the success of forestry in the State if pursued rightly.

The most prominent of the forestry plantings and estates are those of P. J. Eigenmann, Rockport, Ind.; The Oakland City Land and Timber Co., Oakland City, Ind.; B. B. & J. E. Leavitt, Vernon, Ind.; Senator John W. Parks, Plymouth, Ind.; Hon. Q. A. Myers, Logansport, Ind., and A. L. Buchanan, Lake Cicott, Ind.

The planting of Mr. Eigenmann at Rockport, Spencer County, Indiana, contains 420 acres, and is hilly, broken upland of porous sandy clay containing an abundance of oxide. His object is a sheep-pasture farm and timber estate for his one-year-old son. He will plant black locust and chestnut. The former tree is a great aid to the stand of bluegrass on such lands. The chestnut will be confined to the hard clays which occur in spots upon such land areas.

The Oakland City Land and Timber Co., Oakland City, Ind., has purchased 400 acres of land in Orange County near West Baden and will conduct the same exclusively as a forest and timber-growing farm. About two-thirds of the tract is covered with a fine stand of second-growth hardwoods, which will be put in a state of splendid cultivation to let grow into a commercial forest. The cleared lands will be planted to trees and seeds for the purpose of a permanent forest. The same plans will be followed as are in vogue at the State Experimental Station. This corporation will plant mostly walnut, black locust and chestnut. It is their intention to establish other estates from time to time as they can find suitable grounds.

The forest estate of B. B. and J. E. Leavitt, Boston, Mass., who have purchased 160 acres of land near Vernon, Ind., will be conducted jointly as a hardwood forest and black locust growing for fence posts and railroad ties. All the open lands and fields together with the rocky slopes will be planted to black locust. The existing forest area will be put in a good cultivated state to grow into a hardwood forest. One hundred and twenty acres of this tract is now planted and growing, 200,000 locust seedlings having been planted thereon.



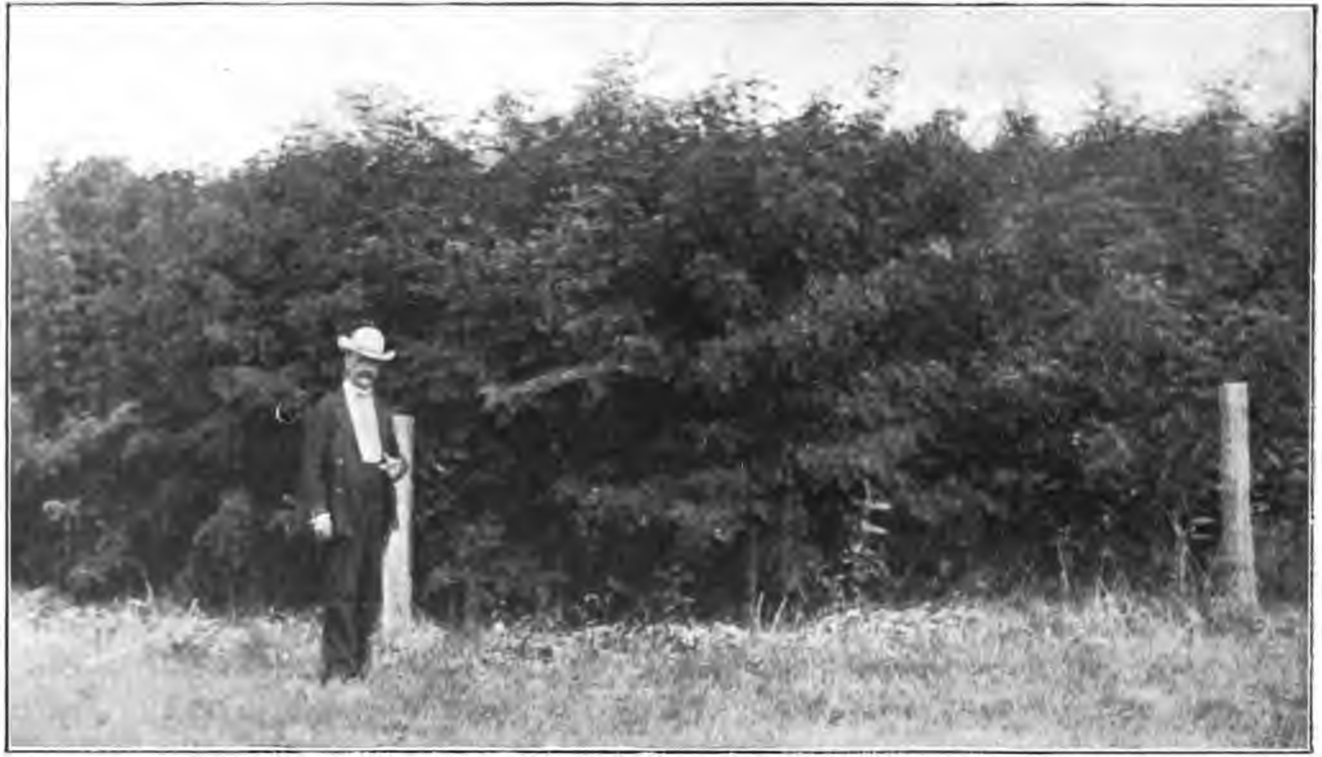
No. 7. A view of the one-year-old catalpa planting by Senator John W. Parks, Bourbon, Ind.

Senator John W. Parks, Plymouth, Ind., has a catalpa planting of 18,000 trees now well under way. This planting is on his farm at Bourbon, Marshall County, Indiana, and is on land adjoining the city limits of that town. The land is valued at $125.00 per acre. Senator Parks is following the instructions of this office in his work. The trees are permitted to grow from two to three years after setting and then cut back to the ground in September to permit sprout growth. By this method the tendency of that tree to crook and branch low is overcome. The purposes of this planting are railroad ties and fence posts.

Hon. Q. A. Myers and A. L. Buchanan, Lake Cicott, Cass County, Indiana, each have large black locust plantings of 15,000 and 20,000 trees on the sandy ridge lands of their farms. The purposes of their plantings are threefold: railroad ties, fence posts and to prevent erosion. No particular account can here be given of the several hundred post-timber plantings for individual farm uses. In every community throughout the State black locust and catalpa speciosa plantings in small areas for farm supply can be found. This feature of the work is well promoted. This work is mostly conducted from this office through correspondence.. Directions for the soil preparation, the purchase of seedlings or seed and the planting can thus be outlined when the drainage and soil character are given by letter. The office funds will not permit of the attempt to visit and inspect personally all such plantings.

The reports mailed from this office are definite in the details of planting work, and they are mailed to all seeking knowledge for planting.

The 9th and 10th of last August the Board entertained the State Horticultural Association for its midsummer meeting at Henryville, and though the weather was very inclement, a good number of visitors attended and observed the Reservation and the work being conducted. This meeting of the association not only was of good advantage in extending a knowledge of the institution and forestry work, but was a good thing in exhibiting Southern Indiana as a fruit-growing region.



No. 8. A view of the black locust planting by Q. A. Myers. Lake Cicott, Ind.

Forest Fire Legislation.

Comprehending to a good degree the carelessness exhibited in the matter of forest fires and the great amount of damage done annually by them and after devoting much time and study to the various forest fire laws and forest fire systems of other States and countries, the following act was passed by the last General Assembly:

AN ACT providing for protection to forests and repealing an act entitled "An act for the encouragement of forestry," which became a law without the Governor's signature on March 8th, 1899, and printed at page 570 of the published acts of that year.

(H. 246. Approved February 27, 1905.)

Forestry—Setting Fire to Woods—Penalty—Prosecutor.

Section 1. Be it enacted by the General Assembly of the State of Indiana, That any person who shall set fire to any woods belonging to another or shall place a fire on his own property and permit it to spread to the woods of another shall be liable to a fine of not less than $5.00 or more than $50.00, and, furthermore, shall be liable to the owner or owners for the full damages sustained by reason thereof, and it shall be the duty of the prosecuting attorney of the county to faithfully investigate and prosecute each and every case, and any failure to so do by him shall be sufficient evidence for his removal from office, and his bondsmen shall become liable for the full damage hereof sustained.

Road Supervisor—Duty as to Fire.

Sec. 2. It shall be the duty of the township road supervisor when any woods, as in Section 1, shall become on fire in his road district to employ such help as he may need to extinguish such fire, and himself and such help as he employs shall be paid by the township trustee from the general expense funds of the township at the rate of $1.50 per day for the time actually occupied in extinguishing such fire.

Repeal.

Sec. 3. That an act entitled "An act for the encouragement of forestry," which became a law without the Governor's signature

March 8, 1899, and printed at page 570 of the published acts of that year, be and the same is hereby repealed.

The beneficial elements of this law compared with those of other States may be stated here briefly. This law puts the subject directly up against the people, and provides a fire warden in immediate reach. Every road supervisor is made a fire warden for his own road district and he can only draw pay when duty is performed. If a woods becomes on fire and he should summon the citizens to extinguish it they are paid a per diem also. A failure to perform duty calls for the prosecutor to act or he is subject to dismissal from office. The expenses of extinguishing forest fires shall be paid by the township trustee from the general funds of the township. Thus the citizens of each township are made to bear the burden of their own forest fires.

When the citizens are compelled to stand the burden of a few forest fires and the township trustee finds his general funds expended for the conduct of some reckless individual, an effort will then be made to apprehend the guilty person and make him suffer the consequences of his act. It is the close contact of this law to the people that will make it effective. It has been no uncommon thing in past years for reckless hunters or other reckless individuals to set fire to a woods, and the owner paid no attention to it, or if he did he must fight it at his own expense and bear all the damage. The individual who wilfully or by his neglect causes a fire to a timberland is just as guilty and has just as much cause to be amenable as he who sets fire to house or barn.

The simplicity of the law will undoubtedly make it effective. No high-salaried fire wardenships are created. The idea of State fire wardens located at the capital and detailed by the department to the scenes of fire, as is the case in other States, could not do the good that will result from the small army of road supervisors stationed in every community in the State and immediately available in case of fire. A fire warden should fight fire instead of being merely an agent to ascertain the probable cause and report upon the damage done.

The Board will be only too glad to help execute this law and will appreciate the information of any failures on the part of officers to do their duty.

Legislation for the Exemption from Taxation of Forest Lands.

Legislation for the exemption of land areas devoted to forest purposes exclusively was attempted before the last General Assembly, but failed because such could not be done constitutionally. It could not be made to come under any of the five things enumerated in the State Constitution for which property may be exempted. It was attempted because there was a crying demand for the same and because the act of 1899 giving a partial exemption was impractical, and one aim in the legislation attempted was to remedy the faults of that act and strengthen the problem of forestry upon the cheap lands within the State. I can not say that I believe in the exemption of forest lands from taxation any more than any other form of property where the owner is the chief benefactor thereby. I also do not believe that in the end the institution of forestry would be helped by tax exemption. Such a course would remove forestry from the meritorious and place it upon a charitable foundation. It would suffer at any time the charitable element was removed, and consequently would be a menace instead of a beneficial factor to the cause. There is not the slightest doubt but that forestry is a thing of merit and will stand, though it may take a much longer time to completely inaugurate a good policy, but when it is thus established it will remain. An individual who possesses a good tract of forest land and institutes thereon systematic forestry will find that as an investment, a factor for intelligent employment, an improvement adjunct or considered in any sensible manner will find himself thoroughly paid by the merit of the proposition, and he will be much more interested because it is standing upon its merit.

Considering, then, the elements above stated, together with the constitutional violation, no law was enacted for the exemption, either partial or complete, of timber lands from taxation and the act of 1899 was repealed, since it could not be practically operated.

Hardwood Forest Estates.

Investments made for the purpose of establishing hardwood forest estates on the cheap lands of Southern Indiana is a matter which should be well considered by capitalists and corporations having money to engage in a time-maturing proposition. Timber in either log or lumber form will always be a stable article of commerce, and, with the existing condition of forest depletion with but a limited effort at afforestation, the price will constantly advance with time and scarcity of forest material.

The cheap lands of Southern Indiana are excellent for forest growing. Most of such lands are now covered with a fine stand of prime young hardwood trees which, if protected from fire and the ravages of timber vandals and reckless lumbermen who take no heed of sparing a young tree in their attempts to market a product, will within a few years become a thrifty forest of fine commercial promise and value. Experienced lumbermen say that on an average of every 15 or 20 years such areas can be gone over and a large yield of prime lumber obtained. Some assert that instances in their own experience have occurred where the second crop cut within a period of twenty years after all the trees large enough for saw timber had been removed have returned far greater returns in both quantity and proceeds than did the first or virgin crop.

The cost of such lands is only nominal considering everything in connection with them. The expense of placing a good tract of such lands in a prime forest condition is also very inexpensive, and under existing laws fire protection is at hand in every road district throughout the State. These hardwood forest estates will prove very satisfactory to owners if attempted, and those beginning work now will see the wisdom of their conduct in the near future. Evidence of the rapidity of the growth of forests on the knob lands under protection can now be seen at the Forest Reservation, where for three years under good care natural afforestation has taken place and the trees are most excellent both in quality and quantity.

The Trimming of Shade Trees.

(Including a list of trees for city planting.)

BY BENJ. W. DOUGLASS,
Special Field Assistant State Board of Forestry.

Many American cities possess an underestimated and often unrealized wealth in the trees that shade their streets. Some of the old New England towns, whose trees had time to develop their mature beauty, are noted for their attractive thoroughfares.

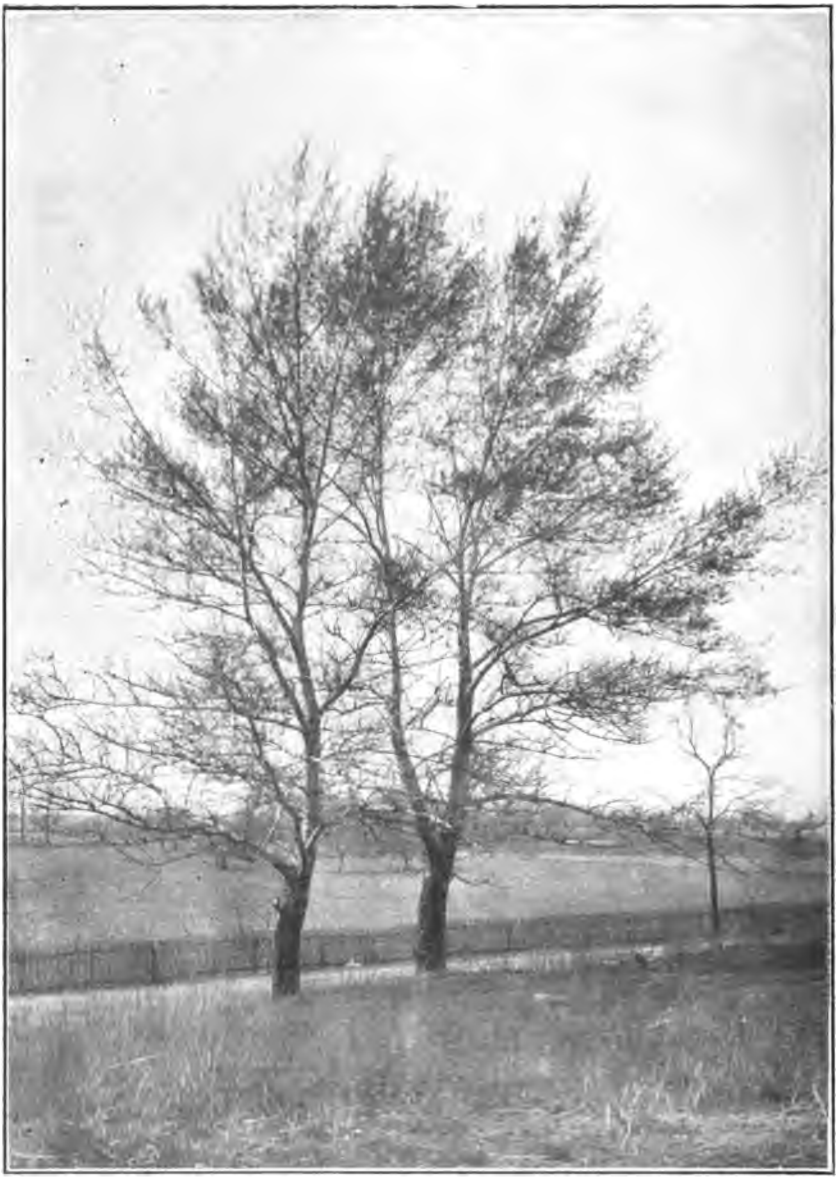
The towering, spreading elms of Cambridge have grown unhampered, undamaged by the destructive "tree trimmer," and their symmetry, grace and strength are vigorous arguments against the methods of pruning now employed.

The "professional tree trimmer" as an individual seems to have been unknown to early America, and his absence is eloquently approved by the stately trees to be found in every old town. And what a contrast these trees are to the hacked, ragged and dying specimens which line the streets of many of our newer cities. In fact, throughout the Middle States it is almost impossible to find a perfect tree within the limits of our cities. A few elms, perhaps, have struggled to maturity and escaped the desecration of the tree butcher, but it is indeed a task to find untouched trees of other varieties. For perfect specimens of our native trees it is necessary to go to the country, where, in some neglected, open wood lot the trees have had a full opportunity to grow as nature intended that they should.

The observation of these facts early led the writer to a realization of the danger which threatened our trees, in the form of that vandal par excellence, "the professional tree trimmer."

Attendant, as tree trimming almost invariably is, by serious if not fatal results, I have been interested in learning some of the reasons why intelligent property owners permitted their shade trees to be butchered.

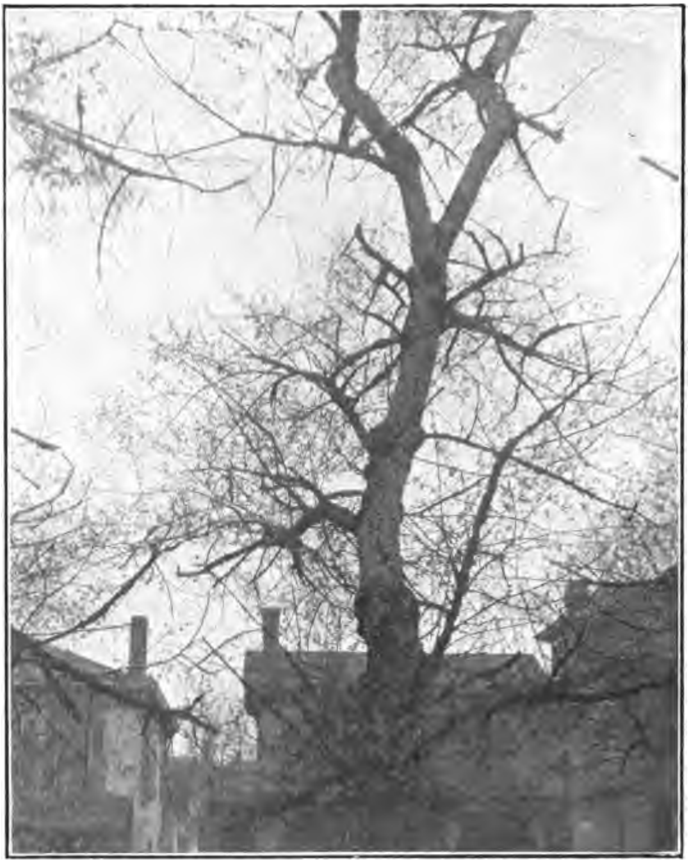
Too often I find that the business man, unable to give the matter



No. 1. Silver poplar (populus Alba) grown in the open country, never trimmed.

his personal attention, has delegated the entire job to a "professional," who, by his own statements is an expert at the work.

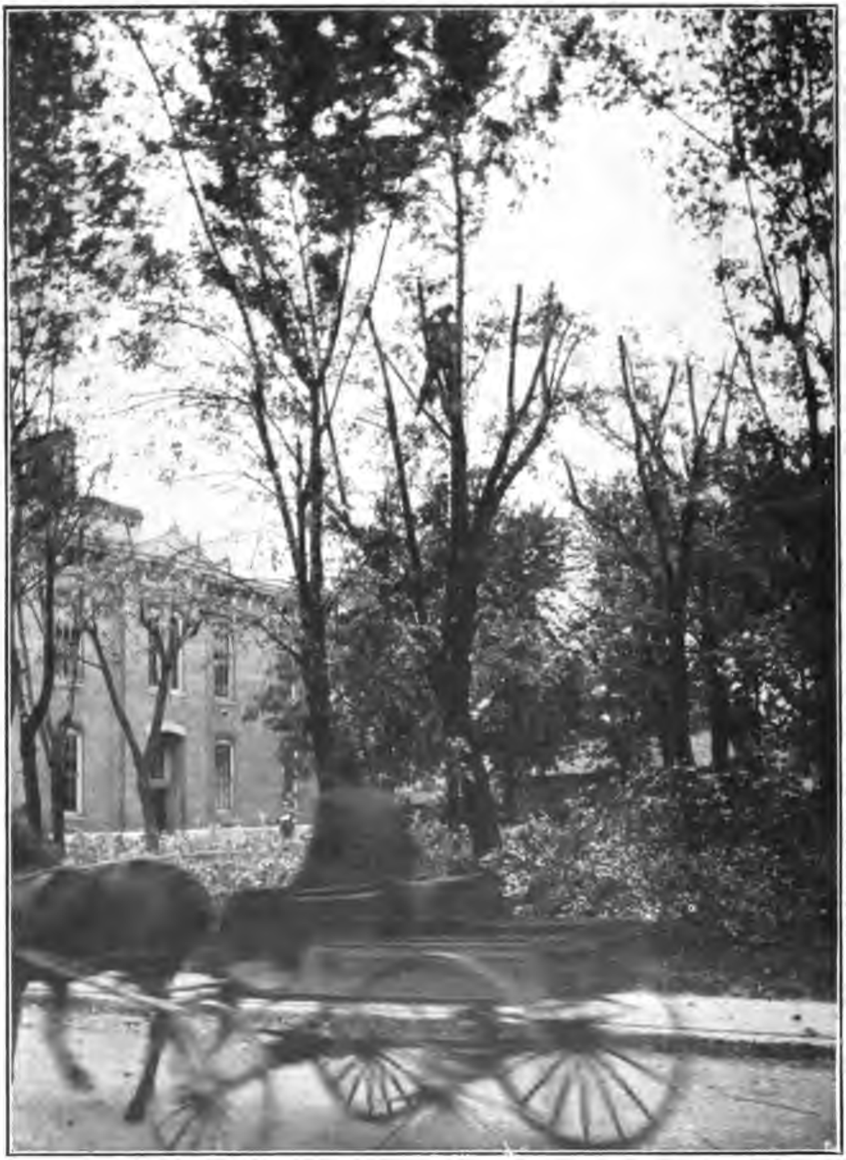
On a few occasions trees are lopped off because their owners are "afraid of falling limbs"—an unfounded fear, as I shall later prove.



No. 2. Type of silver poplar trees to be found in the city. Effect of trimming.

Others trim trees in an effort to improve the natural shape of the variety—a process with about as much logic as would be in an attempt to trim a tall lean human being into a short rotund one. Surgery may remove an injured arm, but it will never be popular as a means of increasing the girth.

Then there are those who trim their trees because their fathers did. It's the ancestor worship of America. In their own estima-

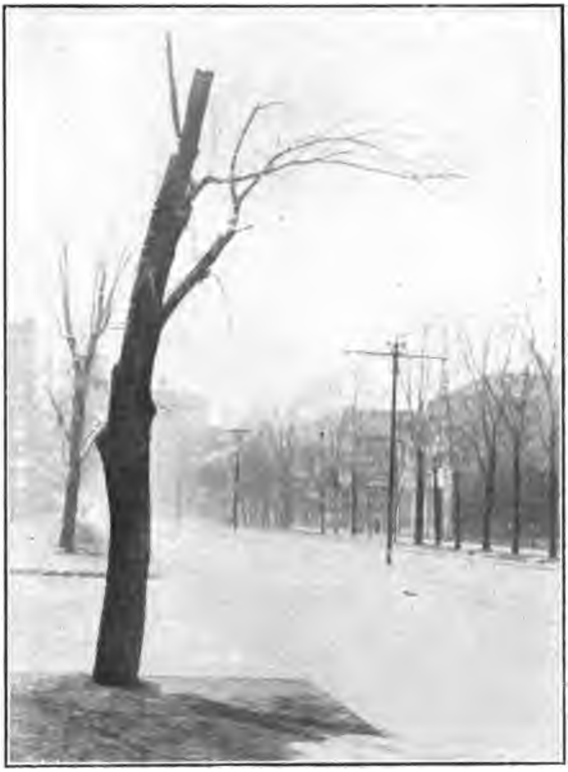


No. 3. A tree trimmer at work on the trees of a public school. The Indianapolis school authorities ordered and approved this work.

tion they are always right, and the botanist who will argue with them must indeed be void of all knowledge of human nature They are like the "Village Oracle" of Joe Lincoln:

> "Well, now, I vum! I know, by gum!
> I'm right, because I be!"

In another class of vandalistic tree slashers is the electric lineman, the tool of soulless corporations, to whom trees are simply obstructions to their wires, objects to be gotten rid of with the least trouble and expense.

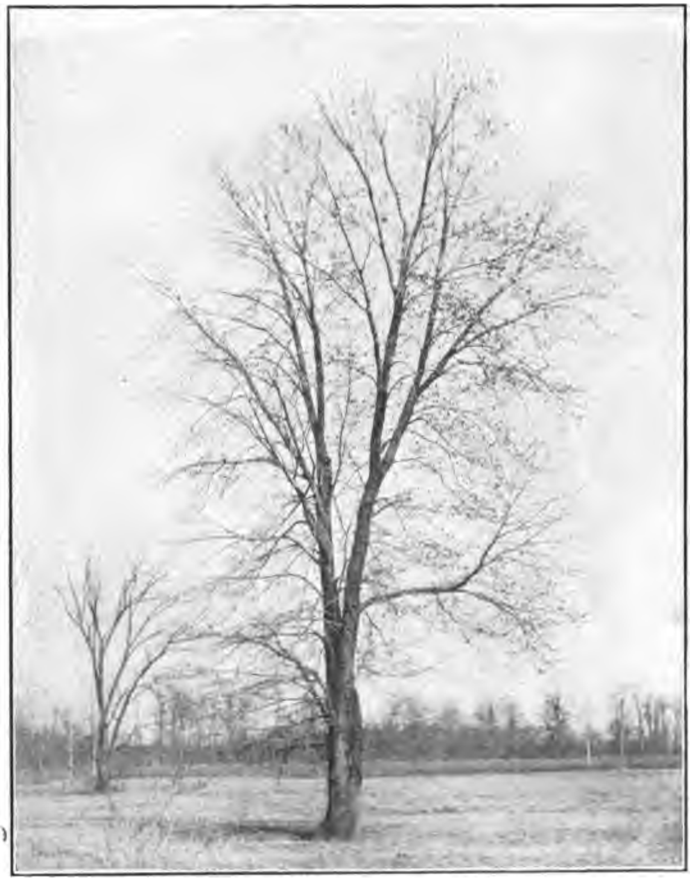


No. 4. Remains of a soft maple. Trimmed to death.

The first class, those busy people who by force of necessity are not able to give their trees their personal attention, is a difficult class to reach by any educational or evangelistic means. And as education of the people is at best a slow process, it would seem wise to remove by law that element which makes tree butchering possible. With licensed tree trimmers and a penalty for ruthless slashing of shade trees, the vandal with the saw and pruning hook would be forced to seek other fields of activity. Against our present-day tree trimmers too much can not be said. The vast majority of them are utterly ignorant of the subject and no more eloquent condemnation of their work could be written than is to be seen in the dead and dying examples of their butchery which line our streets. These tree butchers are often ordinary vagrants who secure some implement that will cut wood, and for a season in spring and fall they set up for tree trimmers. Often I have seen such professionals who did not even own their own tools and expected to borrow a saw and hatchet from their "clients."

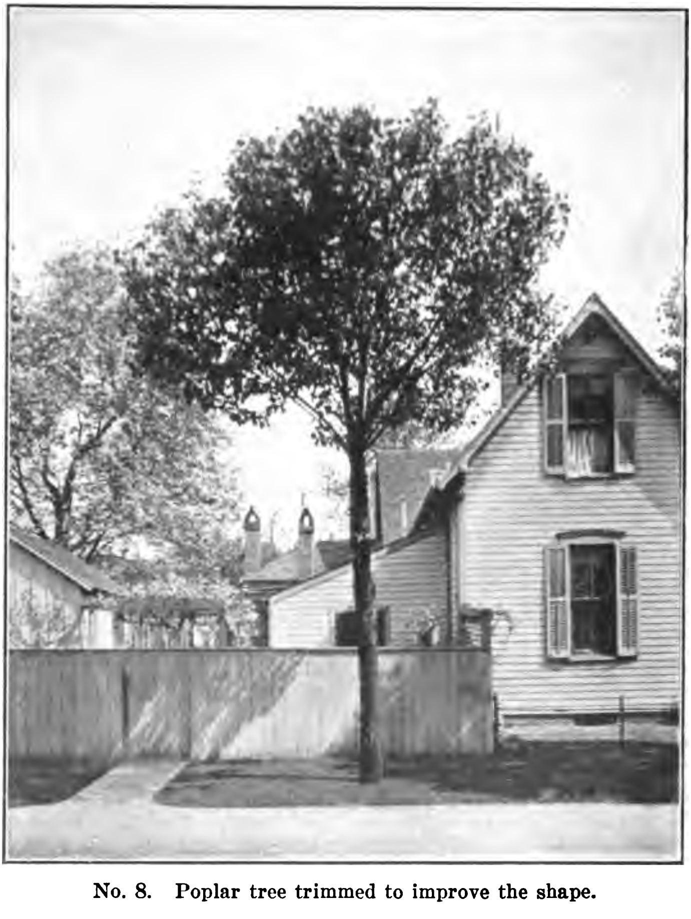
No. 5. Is there anything graceful about this?

A little farther up the scale is the permanent or resident tree trimmer, who has an outfit of tools, including a pair of sharp-pointed "climbers," with which he ascends the tree as easily as a lineman does a telegraph pole, often tearing great gashes in the bark, but always damaging the tree to a considerable extent. This class, while better equipped for their destructive wrok, are no more to be reasoned with than are their more primitive brethren, the "vagrant professionals." They all hoot at the scientist and invariably proclaim that "nature is their teacher." If such is the case, they have fully demonstrated their incapacity for learning. In their ignorance they can not realize that "science



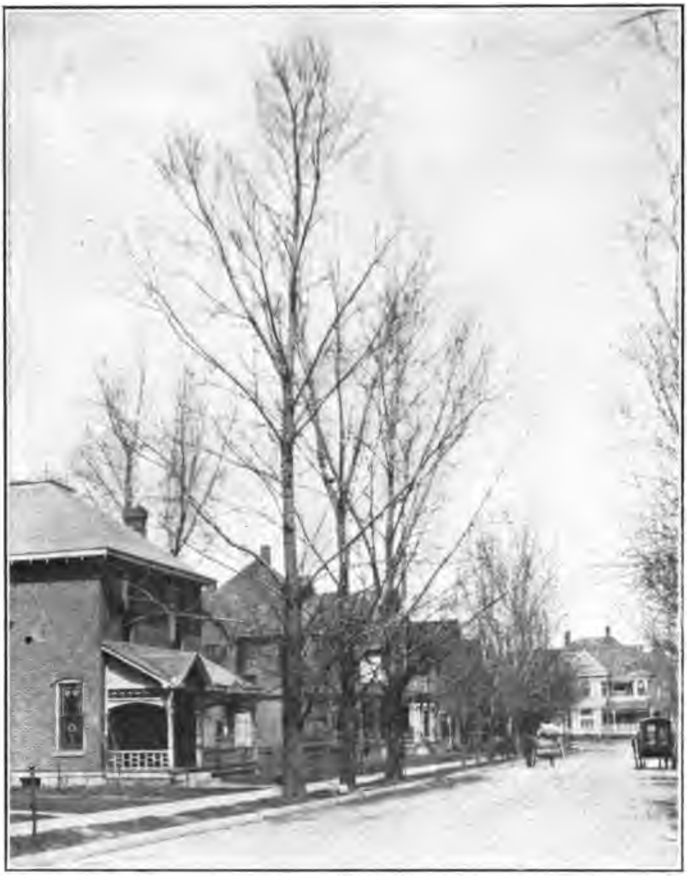
No. 6. Soft maple, same variety as the two opposite.

is truth," and that our conclusions about tree trimming are not drawn from books and the laboratories, but from a long period of intelligent observation in the field. It is natural, too, that if they have brain capacity enough to know the truth in tree trimming that they would try to hide it and encourage the industry which has given them employment for so long. They do not care if they kill a man's trees. They are "out for the money," and as long as people will continue to pay for having their trees butchered the butcher will continue to live easy and laugh at the scientist who would interfere with his outrageous work.



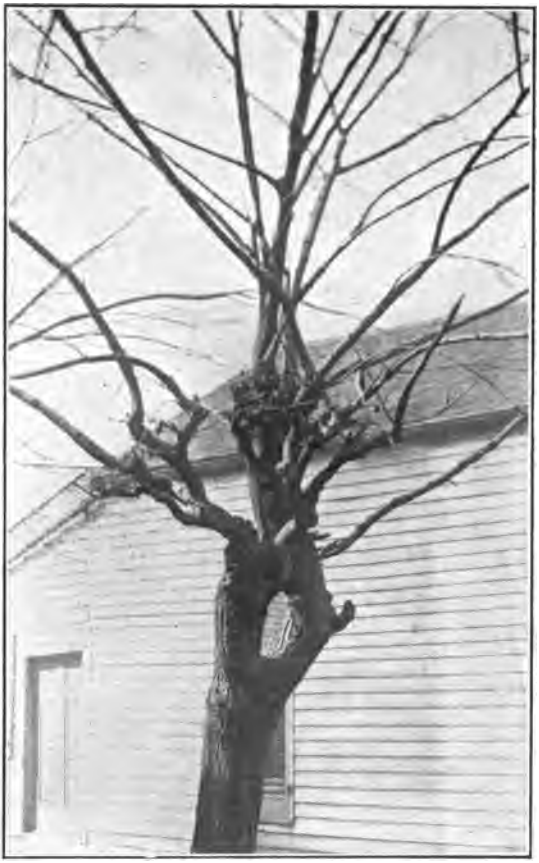
No. 8. Poplar tree trimmed to improve the shape.

The popular notion of a beautiful tree is one with a compact, round top or head, and it is this form that the professional trimmer tries to make *all* trees assume, whether nature ever intended they should grow so or not. Cut No. 8 shows this style of trimming applied to the Carolina poplar, a tree that in a state of nature develops a tall main stem the lateral branches of which make the outlines of the tree the very antithesis of the one shown in the cut referred to.



No. 9. Natural shape of poplar. Compare No. 8.

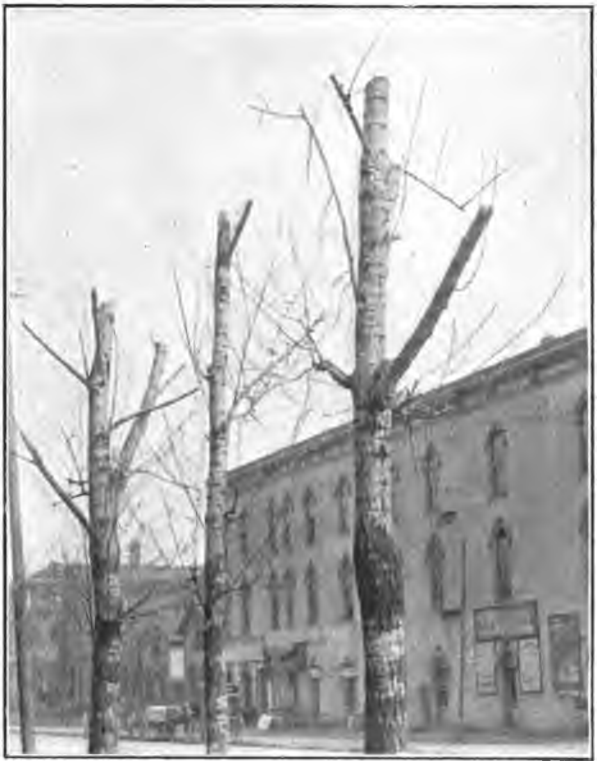
If tree owners insist upon a certain shape or if certain shaped masses of foliage are desired for any special purpose, trees should be planted which will naturally assume that shape. Get away from the old idea of planting any sort of tree and then trimming it to the form desired. Don't try to make a poplar look like a horse chestnut or a weeping willow like an oak. Norway maples, linden, white ash, and other trees to be treated in a separate list, all grow a compact, round head, and if they fulfill your idea of tree beauty, plant one of them, rather than butcher some tall growing tree that does not come up to your expectations.



No. 7. A red maple in an old German garden. Notice the results of the persistent pruning, which the old gardener thought necessary.

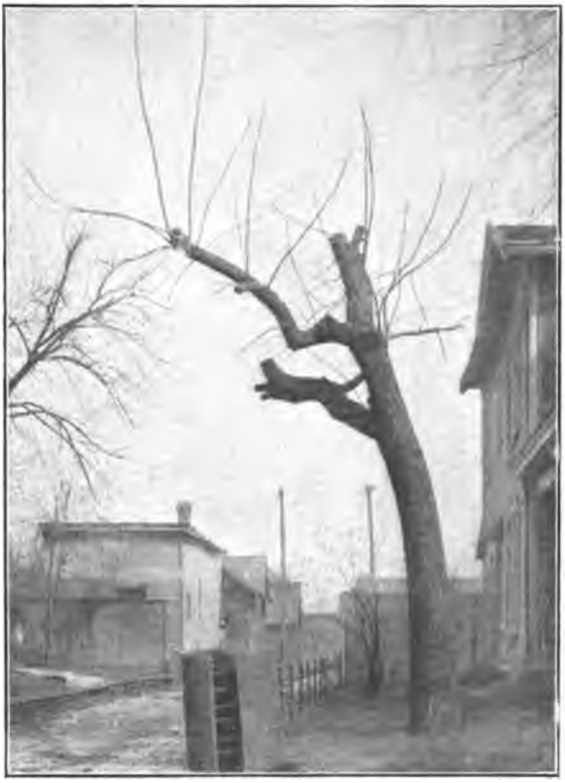
Too often people plant trees unthinkingly, and with no eye for the future—then if the results are not satisfactory the trees get the blame and the trimming.

Another class of tree butchering is illustrated in cut No. 10, and it is hard to conjecture what insane motives prompted such awful work. This sort of trimming (if it may be called by so mild a name) can have but one result—the trees inevitably die. And yet this species of imbecility is rampant throughout the country today, as cuts Nos. 11, 12 and 13 will in some measure show. Such work is more than a demonstration of idiocy, it is an offense against the common decency of nature; it is the destruction of property rightfully belonging to the people and to the State. The profanation of a temple of God would be a no more sacrilegious act.



No. 10. See text.

I was recently called upon to examine a Norway maple tree infested with borers. The owner had first noticed the trouble some three years before, and at that time sent for a "professional tree man." The "tree doctor," self-styled, wisely informed him "that the tree was dying, that the roots were unable to supply nourishment enough for the limbs and the only cure was to cut off some of the branches, so that the remaining ones might get all of the food, and thus be kept alive." Forty years ago that might have passed, but science has progressed too much in the intervening years to be satisfied with any such theory today. One of the first things a student of botany learns, is that *plants make their own food.* Let me outline how they do it.



No. 11. See text.

The roots of the tree gather water from the soil and force it up through the stems to the leaves. This water is in itself not a food at all, for if a plant had to subsist on the matter furnished it by the roots it would soon die. Water is composed chemically of two elements, hydrogen and oxygen, and when the water reaches the leaves it comes in contact with a third element which the leaves have been gathering in from the air. This element is carbon, and is obtained from the air in the form of carbon-dioxide gas. In the presence of sunlight the leaf has the power to combine these three elements, and the result of the combination is some form of starch or sugar, and it is on this starch or sugar that the plant lives. This process of food making is carried on *in the leaf only,* but the finished food is transported through the various plant parts for nourishment or storage as may be needed.*

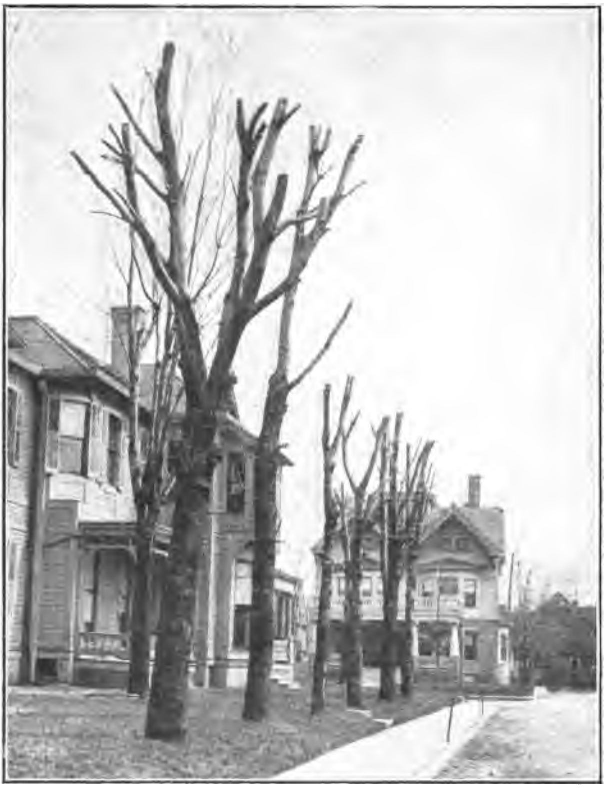
No. 12. These trees died during the past summer and were recently cut down.

Now to get back to our tree trimming, it is easy to see the folly of cutting off live branches "in order to throw more nourishment to the remaining limbs." When you destroy a healthy leaf you lessen the plant's power to care for itself just that much. Every

---

*For the benefit of the critical reader, I will say that the roots also take up from the soil a certain amount of mineral salts in solution. These salts are indirectly necessary, as their presence gives chlorophyll (the green coloring matter in plants) the power to make food. They are not, however, *plant foods* any more than pepsin and hydrochloric acid are human foods. A starving man would not relish a meal of gastric juice, no matter how valuable that substance might be in the function of nutrition.

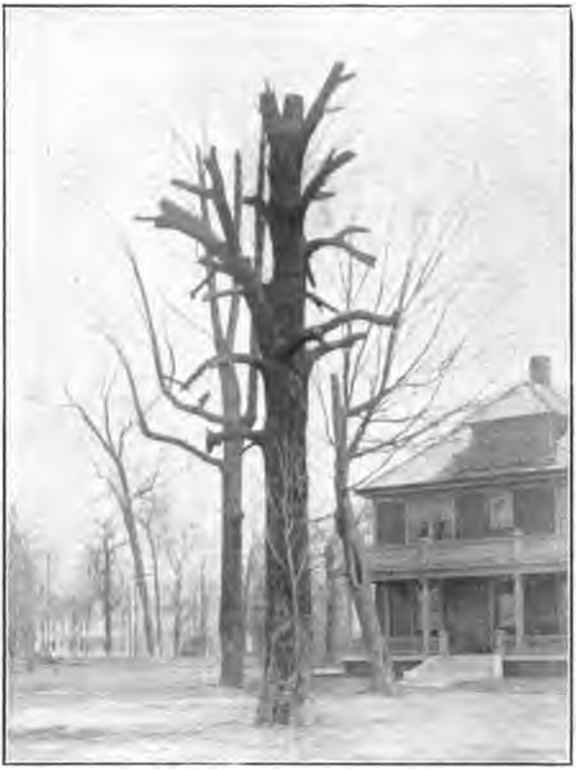
farmer knows that if the bugs destroy the leaves of his potato vines, he will have no potatoes; or if the hail strips the blades from his corn stalks, the grain will not "fill out." In each case the source of starch (of which potatoes and corn largely consist) is destroyed and the plant not only fails to store food but fails to make enough to live on.



No. 13. See text.

As I have said, many people trim trees for fear of falling limbs. If the limbs are dead this is all right, but it is folly to trim a live, healthy tree for any such reason. Cuts Nos. 14, 15 and 16 will show trees trimmed for fear of falling branches. Wherever a large branch has been cut off, a cluster of weak "water sprouts" will develop. Some of them may grow into large branches, and every such branch will have a rotten spot at its base where it joins the old limb, and it is ready to snap off in the first passing storm.

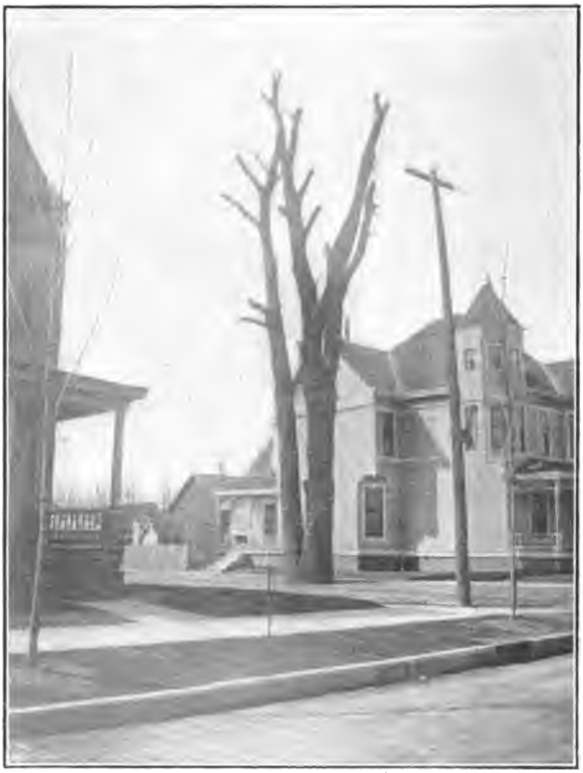
This erroneous theory of tree trimming has been practiced especially on the large native trees near which men have chanced to place their country homes. A dozen cases could be cited where whole clumps of trees have been mutilated in this manner and today every specimen has either died or is full of dead limbs, far more liable to break off than were the original branches of the healthy tree. And what is true of one tree in one locality is true of all trees everywhere.



No. 14. White ash trimmed for fear of falling limbs. (See text.)

Wherever a specimen is topped, the same results are certain to happen, and instead of its being a protection to cut off a large healthy limb, it is a menace, for the limb with which nature will try to replace the lost one is sure to be weakened, as I have said, by its rotten place of origin.

Our last class of tree butchers, the electric linemen, are as a rule simply the tools of some corporation, and until adequate laws are passed giving the State control of all trees on streets and highways, we can say little and do less. It is now simply a personal fight between property owners and corporations, and, as may be supposed, the corporations usually do as they please. It would be hard to estimate the amount of damage which has been done by the electric companies of the State, but it is certainly of such an extent as to demand early legislation of a most stringent order. See Figs. 17, 18 and 19.

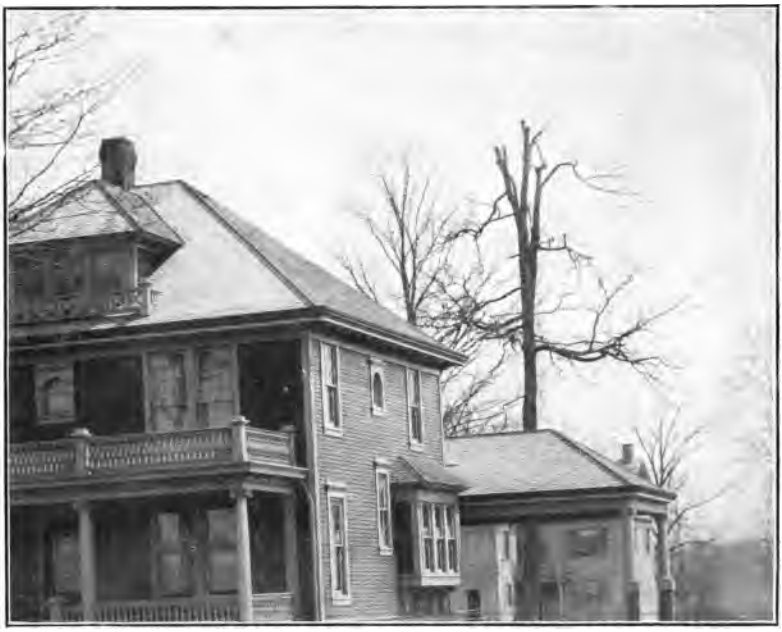


No. 15. Cottonwood trimmed, presumably for fear of falling limbs.

And now the question comes: Is tree trimming ever justifiable? And in reply I wish to say that in my judgment, trees should never be trimmed save for two reasons: First, the removal of dead limbs; second, cutting off lower branches to raise the head of the tree.

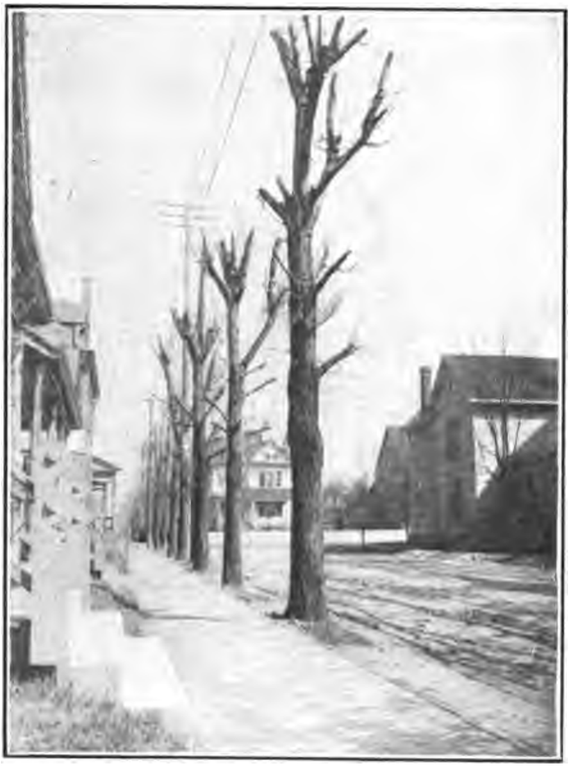
A limb dead or injured from any cause should be promptly cut off and burned. The burning can do no harm if not performed too near the trees, and if the dead branch contains any infection, fire will destroy it and prevent its transmission to other trees. Boring insects of various sorts may get their start in dead limbs, so, as an hygienic measure it is advisable to keep all lifeless branches well trimmed out.

It is a botanical fact that a stem never grows in length after the first year. The top of your tree will continue to grow, but the distance from the ground to the first branches will never be any greater, although the tree lives to be a thousand years old. Where trees are growing close together, as in a forest, they have to grow tall in order to get the necessary light. The dense shade of the tops of the trees eventually kills the lower branches and they fall off, leaving the clear, straight trunk characteristic of forest-grown trees. Where trees stand in the open, this process of natural pruning can not take place and unless you would have a low



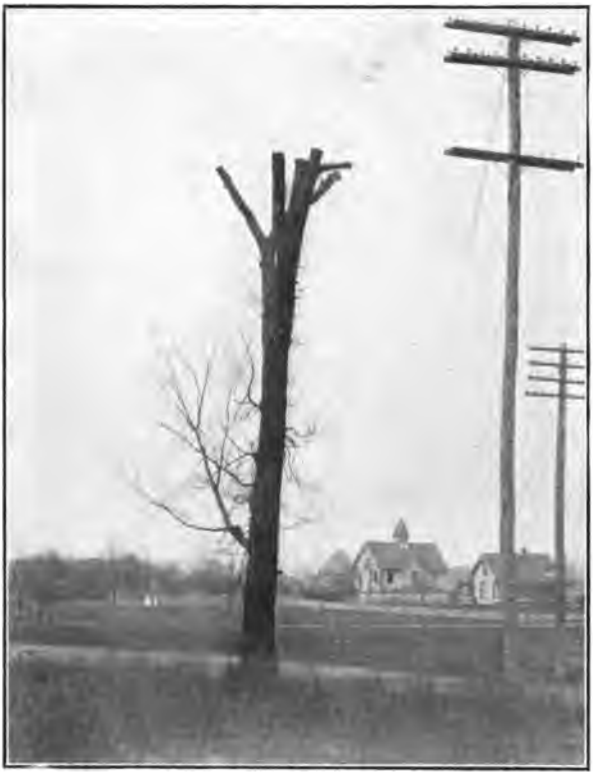
No. 16. Trees near a country residence trimmed because the owner thought "they might fall on him."

spreading tree it will be necessary to remove the lower branches. This should be done carefully lest the young tree be seriously damaged in the operation. With a sharp saw or knife, cut the limb as close to the trunk as possible. This should not leave a round but an oval scar flush with the trunk and easily healed over. It is perhaps best to paint over such wounds, especially if made in spring or summer—fall cuttings are not so apt to be attacked by insects.



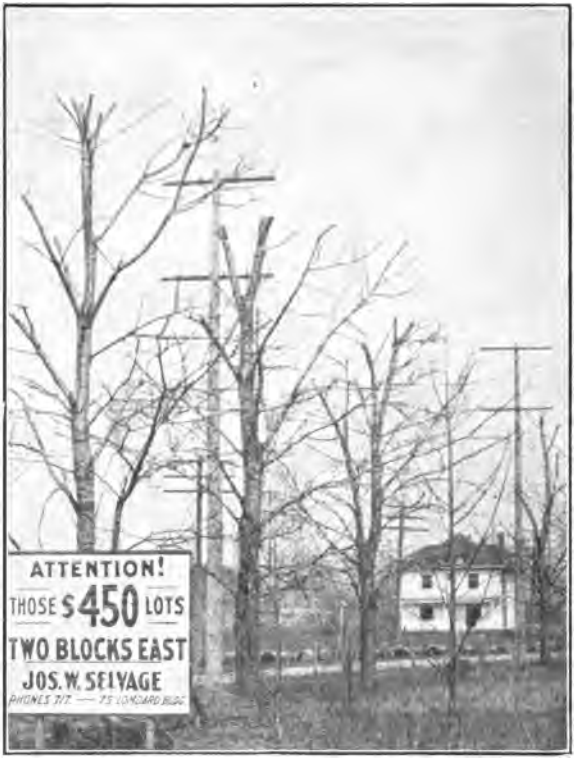
No. 17. Work of electric linemen.

It has been recommended that the limbs of a transplanted tree should be cut back proportionately as the roots have been injured. The theory back of this is that the water-gathering power of the plant has been reduced, and, therefore, the working (water using) area should be similarly reduced. This is no doubt correct, but in trimming a transplanted tree use care in selecting the limbs you remove, cutting only those farthest down on the trunk and leaving entire the main stem, so that a healthful growth upward may be maintained. No tree should ever be set if its terminal bud (that is, the end bud on the very top of the main stem) has been injured or removed. It is also far better to set a tree so small that the roots will not be damaged, and which will therefore require no trimming, than to set a large tree and have it die in a short time.



No. 18. Work of electric linemen.

And in conclusion, just a word of warning. Some of our old-time tree trimmers have evidently seen the "handwriting on the wall," and in the past few seasons more and more have blossomed out and, basking in the prosperous sun of science, are soliciting work as "tree doctors." In some cases they have possessed the ways and means of getting into print—they are all the more dangerous, for some people have the weakness to believe that printer's ink is the paint of truth, and unhesitatingly believe "all they see in the newspapers." Do not trust them, I say, but if you have a tree to trim, or think you have, use your common sense and do, or supervise, the work yourself. If you have a particularly puzzling case, this department will be glad to extend to you such help as is within its power.



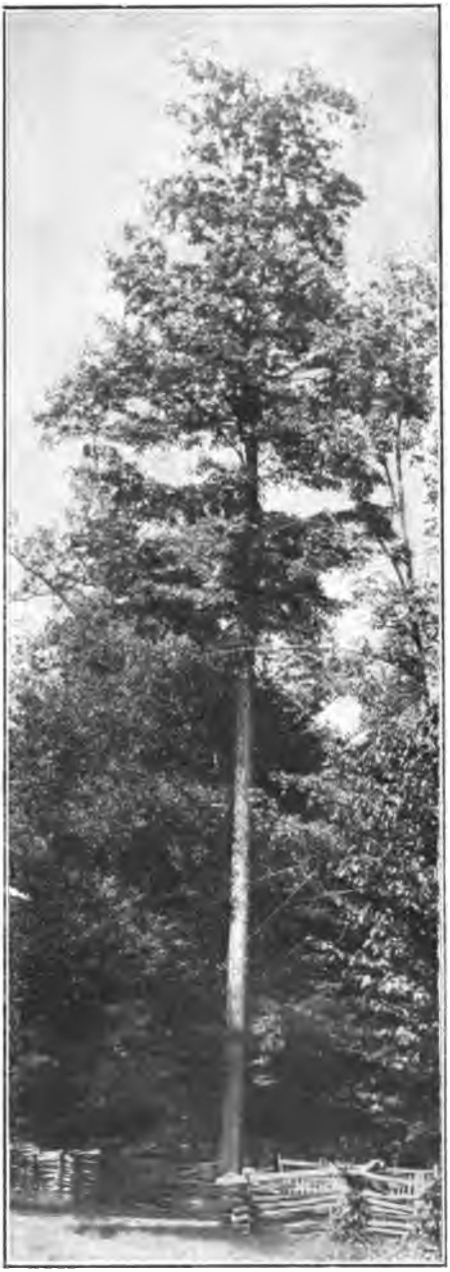
No. 19. Work of electric linemen.

A LIST OF TREES RECOMMENDED FOR CITY PLANTING.

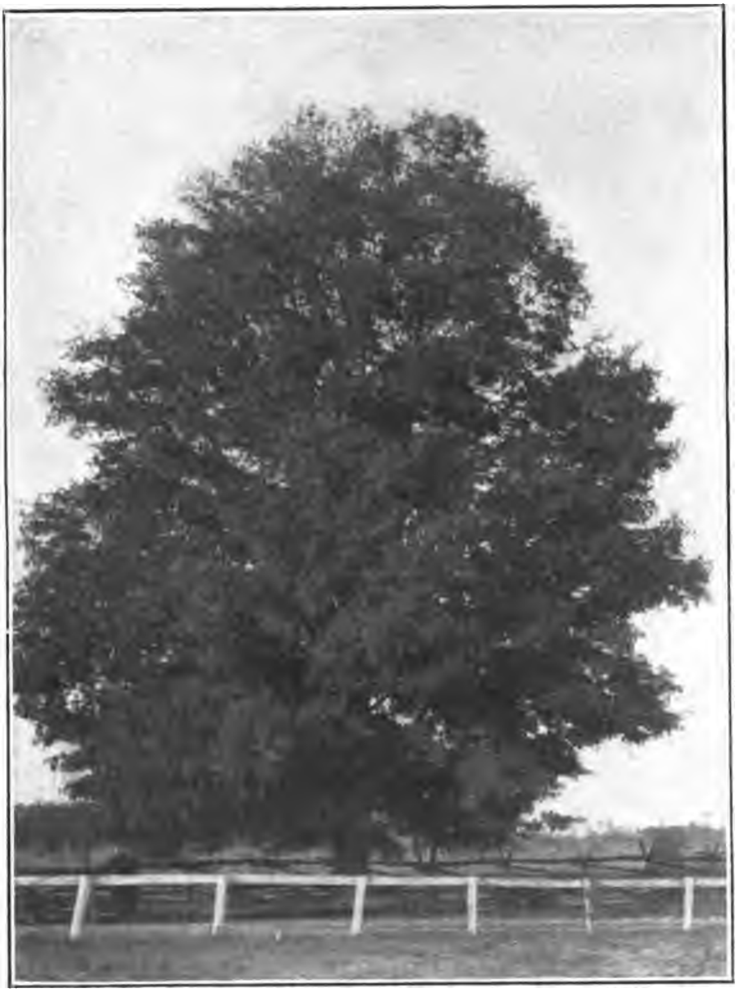
In the following list we do not try to solve the problem of what tree should be planted for each particular condition, that is a question which each planter must decide for himself, and our only aim is to help, if we can, in making that decision correct.

In a country like ours, so lavishly supplied with fine native species, it seems, at least, unpatriotic to resort to foreign trees for the shade and ornament of our streets and lawns. With perhaps three exceptions, the trees of the following list are all native to Indiana, and many of them are cited as having reached their fullest development in the valley of the lower Wabash. The conditions there were perfect for the very best tree development, and it is doubtful if any tree in cultivation could ever attain the remarkable size of some of the giant forms which constituted the native woods of that region. Even granting that it were possible to grow a tree of such size, we could hardly consider a one hundred and ninety foot tulip tree a practical shade producer on city streets. It must be remembered, too, that there is a marked difference in habit between forest-grown trees and those which grow in the open. Figures 21 and 22 will illustrate this difference in the sugar maple. Any tree planted in open ground will tend to form a lower head and become more bushy than a tree of the same species grown in a forest. In the latter environment the surrounding trees cut off the light from the lower limbs and force the tree to present its foliage to the sun at a higher altitude. The lower limbs, no longer able to perform their normal function owing to the shade produced by the higher branches, soon die, and in a short time rot off, leaving the tall clear trunk, characteristic of the forest-grown tree. When the tree has a full supply of sunlight on all sides this process of natural pruning can not take place, and it is often necessary to remove some of the lower limbs of a tree in order to form the head high enough from the ground.

The question of the best methods of growing these native trees is one that the department is now working on and in an early report we hope to present definite information relative to tree-seed germination. Where only a few trees are needed, it is best, if possible, to get seedling trees from the forest. And get *small ones,*



No. 21. Rock maple. Forest grown.



No. 22. Rock maple. Field grown.

small enough to pull up with your hands (Fig. No. 23). Do not rely on any scheme for holding the soil about the roots, no matter how clever it may be, but get a small healthy plant with a strong terminal bud and see to it that this terminal bud is not destroyed, for the upward growth of the tree is dependent on having a strong bud at the end of the main stem.

No. 23. Small enough to pull up with your hands.

It is a curious fact that city trees are more liable to insect attacks than their forest brothers. There are two chief reasons for this. The native insectivorous brids are more plentiful in the country than in the city and no doubt greatly control the larger pests, as the caterpillars and beetles. Second, the city trees are as a rule so weakened by trimming as to give the scale insects an advantage in the struggle for existence. In the city of Vincennes this was noticed even in the case of the boring beetles that trimmed trees were the first to suffer. The untrimmed specimens were healthy and their superior vitality enabled them to withstand attacks which would have been fatal to less vigorous trees.

We wish to speak in general of a few of our native shrubs, many of which can not be surpassed as ornamental plants. The wild crab-apple, with its sweet flowers, is already being planted as an ornamental shrub. The June-berry, with its early clusters of pure white flowers, followed by the bright red, edible fruit, is also being recognized as a valuable variety. The black-haw, the thorns, the dogwoods, the spireas, the northern holly, the red bud, and a host of others are material to make a landscape gardener famous.

ELM.

The American elm (Ulmus Americana, Fig. No. 24) is the elm most commonly planted in American cities. Its broad head and sweeping, graceful branches make it a general favorite as a shade producer. It is, however, slow growing, requiring many years to develop to its full beauty, and in youth is not an especially handsome tree. Of late years three serious insect pests have invaded this country and destroyed many elms. The elm leaf beetle (Galerucella luteola) and the elm leaf caterpillar (Vanessa antiopa) have wrought destruction to many valuable trees.

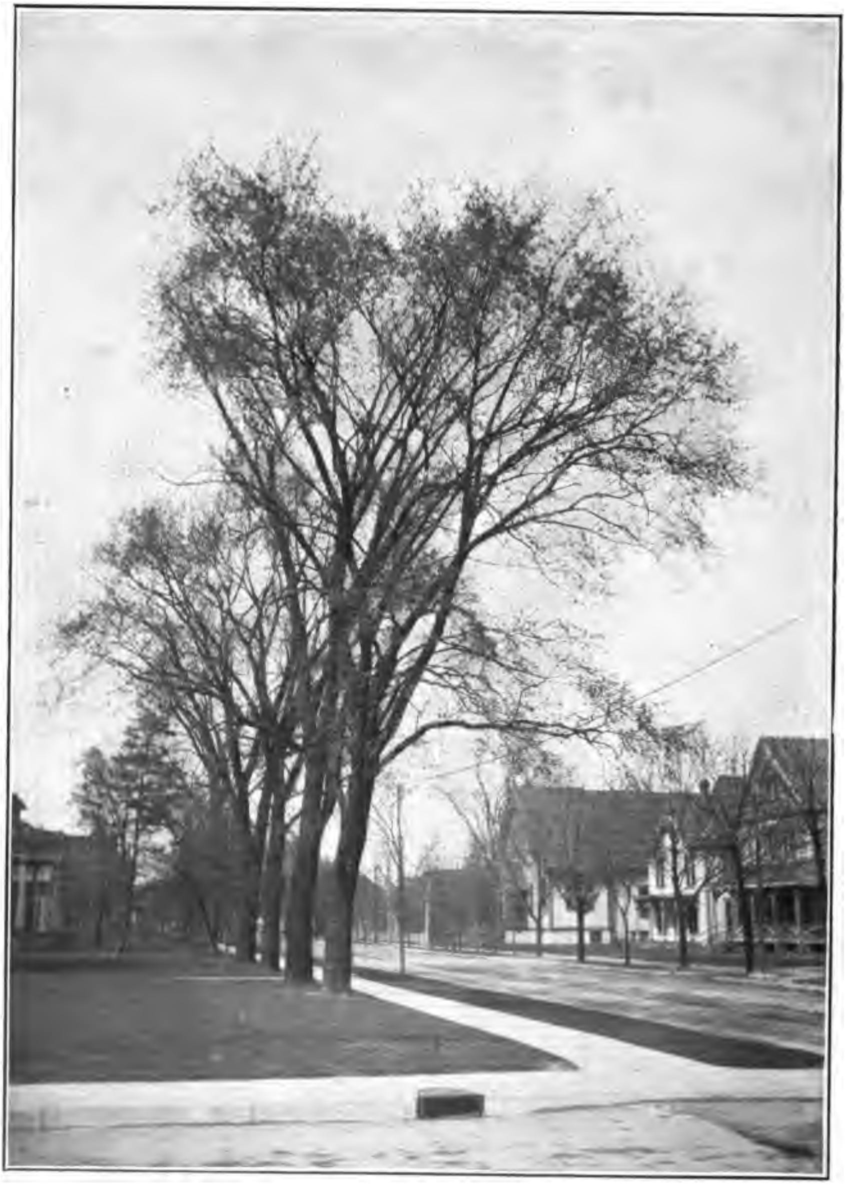
In the city of Vincennes, the elm tree borer (Compsidea tridentata) has killed perhaps half of the elms in the last three years.

The slippery elm (Ulmus pubescens) is a smaller tree not so often planted.

MAPLE.

The two maples most commonly planted are the soft or silver maple and the Norway maple. The latter, as its name implies, is not a native of this country. It is, however, an excellent tree, producing a compact round head densely set with dark green foliage. It seems to be comparatively free from insect pests.

The silver maple (Acer saccharinum) is the most commonly planted maple of all. An untrimmed healthy tree will reach a large size in a comparatively short time. Its long sky-sweeping branches produce a graceful effect when planted in a space which will permit of their full development. The San Jose and cotton maple scale have been very destructive to this tree and must be guarded against.



No. 24. Elms.

The red maple (Acer rubrum) is an excellent tree for city planting. Its red flowers in April, its scarlet winged seeds in May and June, and the glory of its flaming foliage in the fall makes it the showiest of its genus. It is not as large as the soft maple, its head is narrower, and it seems to be free from insect pests.

The two varieties of the sugar maple (Acer saccharum and Acer nigrum) do not do well when planted in cities and a good specimen is seldom seen outside of their native groves.

Numerous imported and cultivated varieties of maples are mostly ornamental trees and are still too much of an experiment to attract the careful planter.

TULIP TREE.

Tulip tree, yellow poplar (Liriodendron tulipifera, Fig. No. 25) is not a poplar at all, but as its flowers might indicate, a member of the magnolia family. No handsomer tree graced the virgin forests of the United States than the "yellow poplar." Its tall form, almost pinelike in its towering symmetry, richly clothed in shining leaves of richest green, makes a tree to be proud of. Quick-growing, strong, good to look at, and free from insect pests, it is a tree admirably adapted to city planting.

HORSE CHESTNUT.

The horse chestnut (Aesculus hippocastanum) is a valuable tree in some locations. It forms a low, rather broad, cone, which becomes higher in old age. In the spring with its great clusters of white flowers it is one of our handsomest and most striking trees. During the late summer and fall it is the host of many insects and the leaves are often eaten completely away, only leaving the ragged stems.

HACKBERRY.

The hackberry (Celtis occidentalis) has been but little planted as a shade tree. Too little to my notion. While it is not as graceful in figure or as rich in foliage as some other trees, it is a rapid grower and makes a good appearance at all stages of its development. Its fruit, persistent on the tree through the winter, is a favorite food for the robin. Its chief insect enemy, the hackberry gall (Pachysylla celtidis-mammae) does no great harm.

WALNUT.

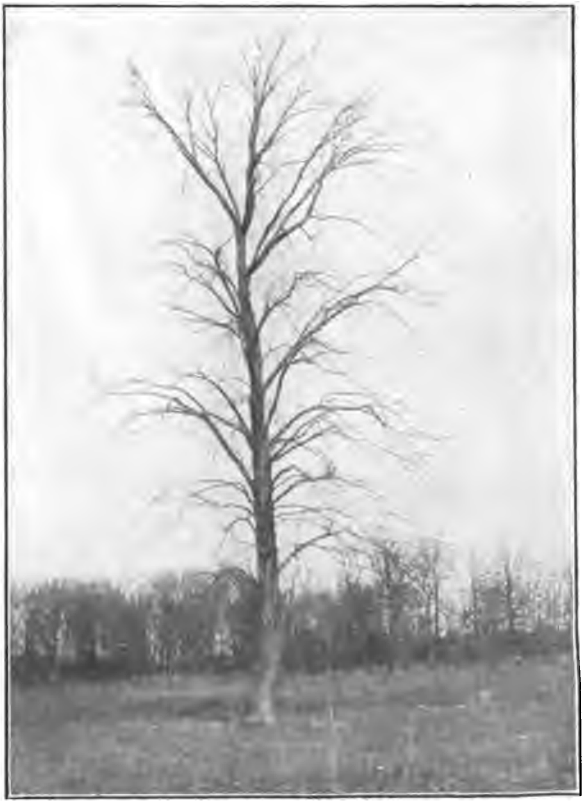
The black walnut (Juglans nigra) was one of the finest trees of the early Indiana forests. Planted singly the walnut makes a broad, spreading, round-headed tree. It is fast growing, but is the harbor of many insect pests. This latter fact makes it a species of doubtful value as a shade producer.

The white walnut is a smaller tree, similar in general character to J. nigra.

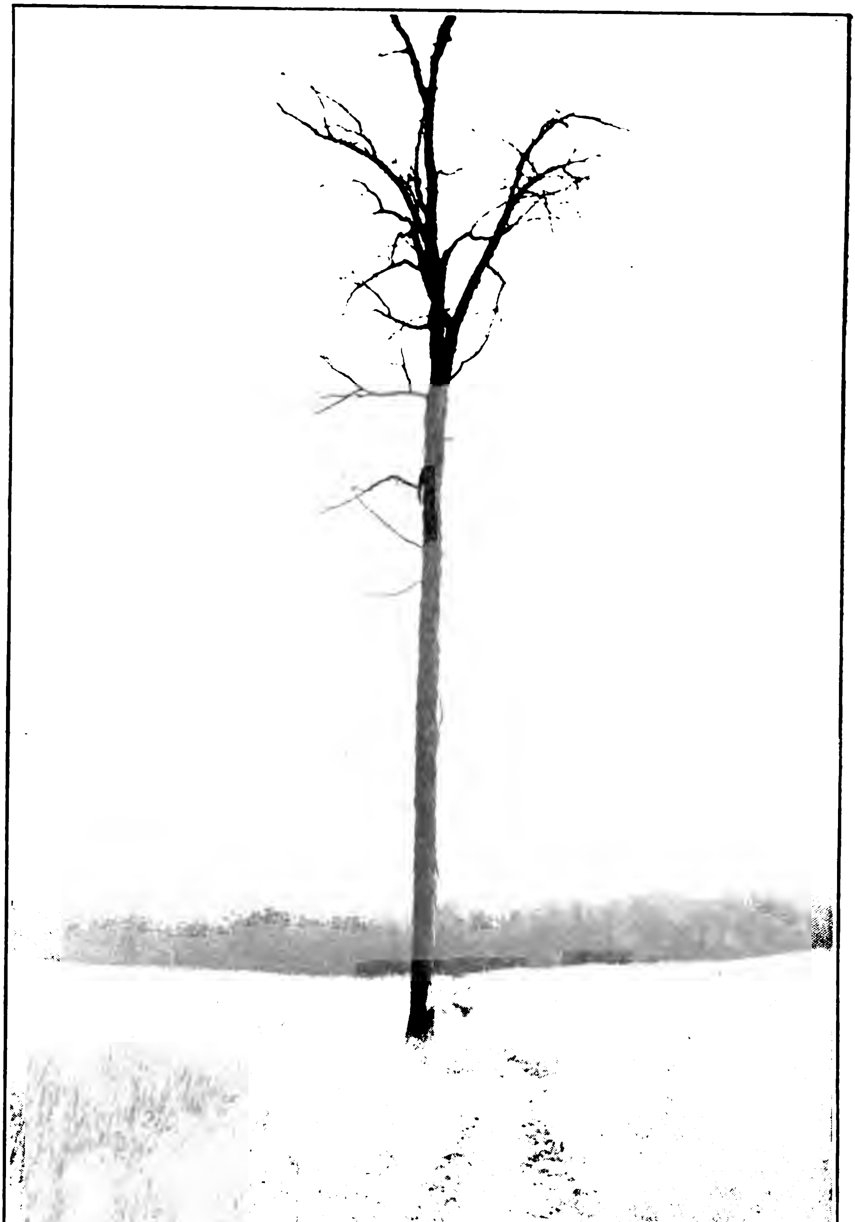
No. 25. Tulip tree.

HICKORY.

Several members of the hickory family would make excellent shade trees if properly handled. Growing as they did in a dense woods, the hickories now existing in a state of nature have developed the tall trunk, destitute of branches for a distance of fifty or sixty feet from the ground, which is so characteristic of many of the trees in our woods. In the open, however, the hickory is a handsome cylindrical tree whose lower branches sweep the ground. The foliage of all the hickories is interesting and not subject to insect attacks. The fruit of most hickories is another thing to induce their general planting.



No. 26. Hickory. Field grown.



No. 27. Hickory. Forest grown.

BEECH.

The American beech (Fagus Americanus, frontispiece) is one of the truly pretty trees of our forests. Its smooth, clear bark gives it a delicacy that is almost feminine. At all seasons of the year the beech is good to look at, from the winter with its graceful tracery of small twigs, to summer, when its glossy leaves rival those of any other tree.

For some reason the beech is not reproducing itself in our woods and it is seldom that one sees a young tree. If this is due to a changed condition of climate, it would not seem to be a desirable species. However, all of the young trees that I have seen are in excellent condition, indicating that our changed climate influences the germination of the seed and perhaps the first year in the life of the tree, and that after the first struggle, the seedling stands perhaps as much show of making a tree as it ever did.

A healthy young beech tree carefully planted and protected from the hot sun should have no difficulty in reaching a full development.

The beech is not a fast growing tree, but is handsome at all stages of its development and is fairly free from insect enemies.

CHESTNUT.

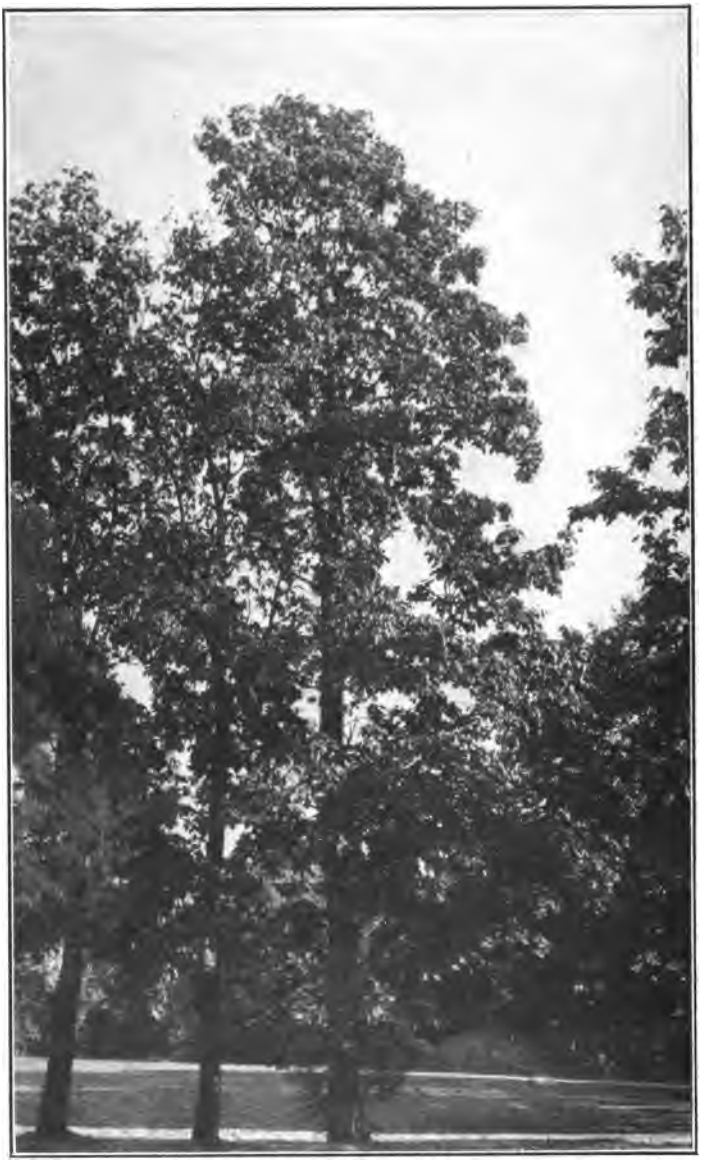
The chestnut (Castanea dentata) is a large tree, not unlike some of the oaks in character, although it belongs to the beech family. It is late in unfolding its dark green glossy leaves.

The chestnut is a rapid growing tree and lives to a great age. Throughout the East it has been extensively planted along city streets and is valued quite as much for its nuts as for its shade.

CATALPA.

The catalpa (Catalpa speciosa) is an excellent tree for city streets. If planted and allowed to take its own course the catalpa develops a short, stout trunk with low spreading branches. If, however, the seedlings be cut off close to the ground at the end of their third year, a tall vigorous sprout will develop which in after years becomes the trunk of a lofty and exceedingly handsome tree. (Fig. No. 28.)

No. 28. Catalpa.



No. 28. Catalpa.

The catalpa is a fast-growing tree not bothered by insect pests. In the spring the great clusters of showy flowers make it a striking object.

The eastern variety, C. catalpa, is not as hardy a tree as our western C. speciosa; the latter is in every respect the most desirable.

BLACK CHERRY.

The wild black cherry (Prunus serotina) is one of Indiana's most valuable timber trees. In the forest it develops a tall straight trunk free from branches for many feet above the ground. Grown in the open the branches extend nearly to the ground and give the tree a stout, compact, cylindrical form.

The wild cherry is said to be very susceptible to "black knot," a fungus disease common to plum and cultivated cherries. Some farmers object to its presence near their orchards for this reason.

OAKS.

There is a quality of permanence about the oaks. A feeling that if you plant one and go away for a long time it will still be there to welcome your return. All of the oaks are long lived, not all of them are slow growing. The white oak, the largest of the genus, and the most valued for timber, is a slow-growing tree, and doubtless attains an age of many hundreds of years. When planted in the open it develops a broad spreading head supported by massive boughs, quite at variance with the tall straight trunk of its forest form. In the fall the deep green foliage of the white oak turns a rich dark red, a color not so brilliant as the maples possess, but nevertheless strikingly beautiful. With its great age, immense size, and slow-growing propensities, the white oak might properly be called the tree of posterity.

The red oak, pin oak and black oak are the fastest-growing trees of the genus. The red oak, a model of massive strength, is perhaps the most beautiful of the group. Its stately limbs are clothed in foliage of the deepest glossy green, which in autumn becomes quite as rich a red.

The black oak is often mistaken for the red, which it greatly resembles. It may be known, however, by its deep yellow *inner* bark, which at one time was extensively used for dyeing.

The pin oak is a smaller tree, frequenting marshy places, and demanding a liberal supply of water for its best development. Its deeply cut leaves and drooping branches give it an air of grace not possessed by any other oak. The lower limbs of an old tree are inclined to die and become straggly.

No. 29. White oak. Field grown.

ASH.

The white ash (Fraxinus Americana) is the most graceful of its genus, and is an established favorite in many localities. The foliage of the ash tree is its chief beauty, and while forming a dense shade, is of such a character as to reveal the dark lines of the branches even to their tips. In autumn the white ash turns a rich purple color and then it is indeed a marked figure among trees.

The green ash (Fraxinus lanceolata) is a small tree but one that will no doubt prove excellent for city streets, owing to its ability to withstand the effects of prolonged drouth.

The blue ash (Fraxinus quadrangulata) is a native of the Mississippi Valley and is an excellent tree for city or park planting.

The black ash (Fraxinus nigra) is a tree of the swamps and river banks. Although, in some respects one of the handsomest of its tribe, it is a slow grower and is short lived.

The ashes are said to be subject to many insect pests. Our experience in Indiana does not confirm this statement of Eastern writers.

SYCAMORE.

The sycamore (Platanus occidentalis) is easily the most picturesque tree native to this country, and as its values come to be realized it will be more generally planted. Its large leaves, its rugged form, and its peculiar bark combine to make it a unique figure among trees. When planted singly in a large space the sycamore develops a very symmetrical shape (Fig. No. 30), but when confined or crowded it assumes the more regular and less conventional appearance, which we commonly associate with it.

The sycamore is a fast-growing tree very free from insect pests. It must be freely watered, especially if planted in a dry situation.

KENTUCKY COFFEE TREE.

The Kentucky coffee tree (Gymnocladus dioicus) is one of our most rapid-growing trees, and in the summer when it is clothed in its dress of deep green compound leaves it is a very handsome tree. In the winter, however, it is rather desolate looking, owing to the absence of all small branches. This stumpy appearance is characteristic of all trees having large compound leaves, the division of the leaf securing the proper light relation and avoiding the necessity for twigs. The tree is quick-growing and free from insect enemies.

AILANTHUS.

The ailanthus (Ailanthus glandulosa) is a native of China. It is quick-growing, does well in almost any soil, and in summer is a handsome tree. Its large compound leaves give it in winter the same stumpy appearance mentioned of the coffee tree. Owing to its freedom from insect enemies and ability to care for itself the ailanthus has been recommended as a city shade tree. The chief objection to it is that it is short lived, and during the flowering season it gives off an unbearable odor.

No. 30. Sycamore.

LINDEN.

The American linden (Tilia Americana) is one of the handsomest trees of our woods. Its erect trunk crowned with a head of spreading branches makes a tree that is an admirable shade producer. Its profusion of dark green leaves lend a massiveness to its foliage that no tree surpasses.

It is not a fast-growing tree but lives to a great age. Eastern writers say of the linden that it is subject to the attacks of many insects. Our observations in the West do not bear out this statement.

MULBERRY.

Some varieties of the mulberry, notably the Russian, are proving excellent shade trees for city streets. They are fast-growing trees and are supplied with handsome foliage. During the season when the fruit is ripening the mulberry tree is a great attraction to the birds, great flocks sometimes gathering to enjoy the berries.

SASSAFRAS.

For peculiar beauty of form and foliage few trees excel the sassafras. It shares with the mulberry the distinction of bearing leaves of variable character, ranging from an entire outline through the stages to a deeply three-lobed form. The autumn colors of the sassafras are deep, rich and beautiful.

The one drawback to the tree is its habit of sprouting from the roots and surrounding itself with a small thicket.

HONEY LOCUST.

Honey locust (Gleditsia triacanthos) is the common thorn tree of our woods. The thorny trunk of this tree sometimes attains a height of over 125 feet and a diameter of 5 feet. It is a fast-growing tree and is planted for its durable timber, useful as railroad ties and fence posts.

As a shade tree it is not so well known, but its handsome habit and quick growth seem to make it a valuable variety.

BLACK LOCUST.

The black or yellow locust (Robinia Pseudacacia) is the tree so commonly grown for fence posts and railroad ties. The early settlers appreciated its value as a shade tree and today many fine specimens are to be seen about the old farm houses throughout the country. It is a fast-growing tree and in May and June, when it is covered with its drooping clusters of pure white flowers, it is a most striking figure.

The locust borer, its chief insect enemy, is to be guarded against. Many young trees are killed by it every year.

SWEET GUM.

The natural range of the sweet gum (Liquidambar styraciflua) did not extend north of the latitude of Indianapolis. When planted north of this region it is maintaining itself well and seems to be a most desirable species to plant. In outline it might at first be taken for a sugar maple. Its foliage, too, is maple-like and in the fall the star shaped leaves glow with brilliant color.

The sweet gum grows rapidly in any good soil and withstands city conditions well.

WHITE PINE.

In Indiana the white pine does not reach the magnificent development which characterizes the pine trees of the north. It does, however, make a tree of fair size and is undoubtedly the best of the evergreens. For deep, rich color the green of the pine can not be surpassed. Nor is it a richness confined to any particular season, it is a constant quality supplying masses of color when all of the other trees are brown and bare.

In mythology many "talking trees" are noted, especially the oaks, but they are only babblers beside the pine. The pines, of all conifers, are positively conversational, raising their voices now to one another, now to man, and yet again united in one powerful chorus, singing to the universe. The song of spring in the pine woods is the song of awakened life and love, gentle, though ever strong and deep. As the winds blow into summer and die away, the voices of the pine are subdued, drowsy, waiting for the winds of autumn to return and stir them again in protest at the coming winter. In winter, the pine becomes boisterous, warlike, shouting back the battle-cry of the north wind with a roar. And with what a valor have the pines, centuries old some of them, withstood this yearly battle with the wind, no wonder they, and they alone, people the north country. They are the Puritans among trees, growing upright and to giant stature in the face of opposition and resistance and lapsing into mediocrity when that opposition is removed.

SPRUCE.

The Norway spruce, one of the quickest-growing conifers, has already shown itself to be a practical tree in the Middle West. It grows to a considerable height, and while it is not to be compared to the pine, it is an acceptable evergreen because of its rapid growth.

Some Insect Pests of Indiana Trees.

BENJ. W. DOUGLASS.

The object of this report is to present in condensed form some definite information regarding the various insect enemies of Indiana trees and the best methods of fighting them.

Many of the subjects herein treated have been ably covered by bulletins of the United States Agricultural Department and by the agricultural schools of the various States, and the only way in which we can hope to improve upon them is in the matter of simplicity. What we have to say we will say for the benefit not of the scientist but of the layman who finds his trees infected and knows not the means of combatting the trouble.

We have but limited means at hand for gathering data of the spread of the more recently introduced insects, but we can say this: do not consider yourself or locality secure from the attack of insects simply because they have never been found near you. The San Jose scale, one of the most dangerous insects of the list, has within the past ten years practically swept the orchard areas of the United States—and this in spite of strenuous efforts of the National and State governments to prevent it.

Tree destruction by insects is a serious problem and one that must be promptly met if it is to be solved at all.

When a destructive insect is first noted in a locality measures should be taken to check its spread at once. A little concerted action on the part of the city, county or township authorities will often result in the extermination of the pest before it has time to get a firm hold on the locality. It is certainly much cheaper to treat a few scaly trees in a certain district than to wait until the disease has become epidemic. And yet local authorities fail to make provision for fighting insects on a few isolated trees on the ground that it is too small a matter to deserve attention. A single tree full of San Jose scale doesn't seem to be a very serious proposition and the idea of spending money for spraying appliances to use in treating it is a ridiculous thing in the eyes of the authorities. When you consider that this same tree will act as a focus from which other trees in all directions will be affected, you can realize the need of early attention. Better to treat the first affected trees at any cost (even to cutting them down and burning) than to permit a dangerous tree enemy to spread at will over the entire neighborhood.

These affections of trees are as contagious among trees as smallpox is among human beings, but the public must be educated to a realization of it. There are always some "old fogies" in every neighborhood who are slow to take up with modern ideas, especially if there is a suspicion that a "scientific feller" is back of it. In Ohio, where a great deal of systematic work has been done, this class of citizens have caused great trouble by refusing to spray their orchards when it was known that San Jose scale was present.

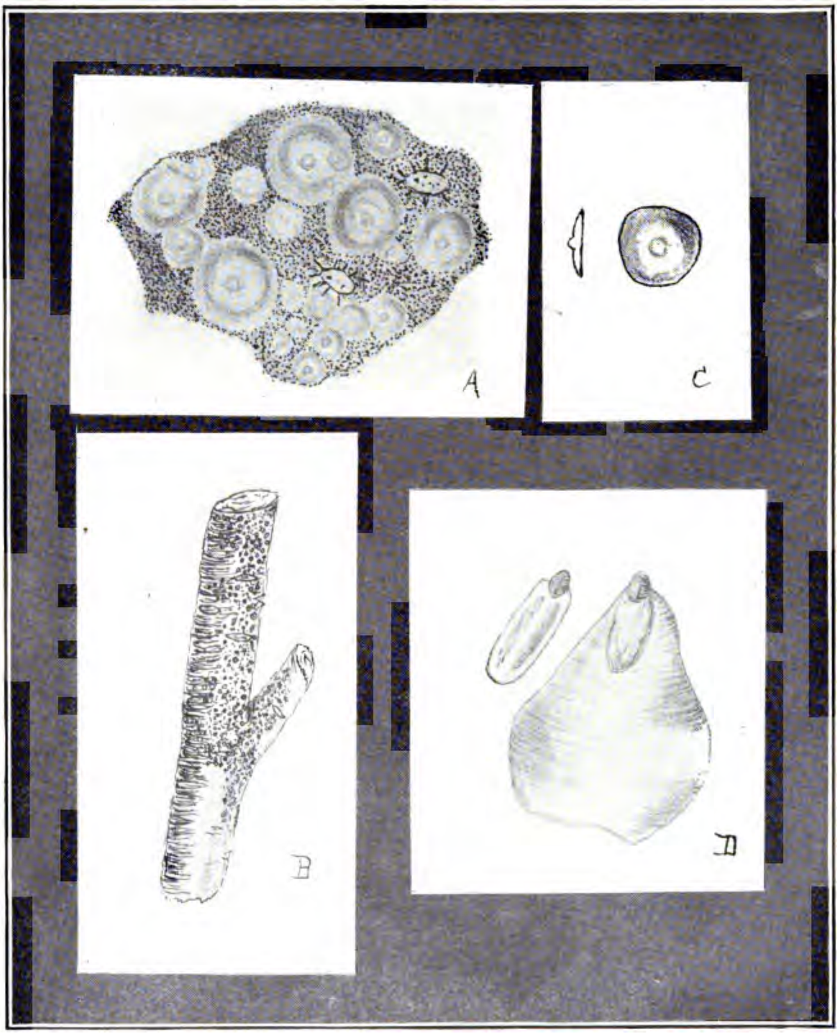
A campaign against any of these insects can only be successful when an entire locality co-operates for the common good. It is only by such co-operation that an epidemic can be stamped out.

SAN JOSE SCALE.

(Aspidiotus Perniciosus, Comstock.)

Since its first introduction into this country many years ago the San Jose scale has spread to a most alarming extent, carrying destruction to shade trees and orchards throughout its course. Coming first to California, presumably from Japan, it has been very generally distributed by infected nursery stock. A few badly infected nurseries in the East have acted as starting points, from which the past has radiated in all directions. Starting and spreading on fruit trees the scale has often attacked and killed forest and shade trees which were growing in the immediate vicinity. Although it is certainly much more abundant and fatal on some trees than on others there is no reason to believe that any tree is entirely immune to its attacks.

Life History.—The San Jose scale begins life as a minute orange yellow insect, crawling freely about over the trunks and limbs of trees, whereon its parent is attached. It is in this stage that the pest is most generally distributed by birds. It will crawl



No. 31. a. San Jose scale under lens. b. San Jose scale natural size on twig. c. Front and profile view of San Jose scale. d. Scurfy scale. Male and female.

upon the feet and legs of the bird and be carried, possibly, great distances before again happening to crawl off upon another tree.

This period of activity continues for, at most, a day or two, when the young scale settles down and begins to secrete the plate or scale proper, which cements it firmly to the bark. It grows during the summer, feeding on the plant juices, which it draws through the bark with its proboscis, and in early fall the eggs are fertilized in the body of the female by the winged male.

At the approach of winter the insect (still containing the half-grown young) ceases feeding and becomes dormant, to resume feeding at the first sign of warm weather. Early in June the young attain their full size and emerge from the body of the parent, thus completing the life cycle. The production of young is continued throughout the season, two broods appearing, one in August and one early in October.

Adult Scale.—The adult scale appears as a small, rounded plate, grey in color, the center darker and elevated, the whole insect not more than one-sixteenth of an inch in diameter. On a badly-infested tree the scales will be so close together as to completely hide the bark, giving the branch an unhealthy scurfy look. If the bark be removed from an infested portion of a tree the layers directly under it will be of a characteristic pinkish brown color—an effect produced by no other scale.

Natural Enemies.—The only enemy of the San Jose scale that is known to have done any material good in overcoming it, is the "Twice-stabbed lady bug" (Chilocorus bivulnerus), a species of beetle found native in doubtless most of the United States. In California this little beetle (black with bright red spot on either side) has been one of the chief agencies in controlling the pest. Other insects have been imported as supposed enemies of the scale, but from all reports nothing has ever come of them.

Treatment.—During the past fifteen years biological stations throughout the country have been studying the problem of the San Jose scale. At first it seemed a simple matter, and the first bulletins stated their recommendations with great confidence and with the air of a final word. *Had these first recommendations been followed* the scale could have been exterminated in Eastern America in two years. But the scientist was laughed at, called a crank and a calamity howler, the people had to see for themselves.

And in some localities they have seen all they desire. Wherever the San Jose scale has obtained a footing and allowed to go unattended, it has spread quietly, insidiously, constantly, doing at first but little damage, then, as its numbers increased, asserting itself and carrying with its death-dealing blows whole orchards before it. As it first appears, in small numbers it is indeed a harmless, inoffensive-looking insect, scarcely distinguishable without a lens, and it is small wonder that people refused to become excited over its depredations in remote regions. A tree with a few scales is like a consumptive with a slight cough. If properly attended to, but little harm is done, but if neglected the invariable end is death.

During fifteen years of experimenting, many washes and sprays have been used with variable success. This department has had no funds for original work and our conclusions regarding these washes must be based largely on the published reports of a number of stations of the United States Department of Agriculture.

The various sprays recommended may be roughly divided into two classes: Those of a resinous or waxy nature, to cement the insects permanently to the tree, and those which penetrate and kill direct. The former are successful only where long continued periods of dry weather are a certainty, the frequent rains of the Eastern States render them worthless in this region.

Of the penetrating sprays one of the most effective is the kerosene emulsion. It has never failed to destroy the scale where properly applied, but it, unfortunately, often kills the tree as well. In the hands of an expert long familiar with its use it has been applied successfully, but the margin of risk is so great that it cannot be recommended to the novice in tree spraying.

Pure kerosene has been used and in some cases failed to kill the tree. It is even more dangerous than the emulsion, however, and except on trees for which there is no hope, it should never be used.

On the Pacific Coast, where the scale has been known for over thirty years, the most successful treatment has been to spray the trees in winter with what is known as the lime-sulphur-salt wash. This mainstay of the Pacific Coast entomologists seems for some reason to lack effectiveness in the East.

A solution of whale-oil soap has been perhaps as effective throughout the East as any other remedy, and is undoubtedly the safest preparation that can be applied to the trees. This or other strong soap washes are especially good where the scale is confined to the trunk and large limbs. In such case a most effective treatment is to scrub the parts with the soap, using an ordinary scrubbing brush to secure penetration. I have seen peach trees completely freed of San Jose scale by this treatment with ordinary home made "German soap." Details of preparation of these washes will be found in notes at the end of this paper.

THE PUTNAM SCALE.

(Aspidiotus ancylus, Putnam.)

This scale belongs to the same genus and closely resembles the San Jose scale. It may be distinguished by its larger size and by the lack of the central rounded protuberance. This scale is not commonly regarded as especially dangerous, and is mentioned here only in its relation to A. perniciosus, as it is often confused with its injurious relative.

SCURFY SCALE.

(Chionaspis furfurus, Fitch.)

While common and widely distributed this scale has seldom become numerous enough to cause any material damage.

As will be seen by the illustration, the male and female differ considerably in form and size. At one stage of its life history the male is winged, as are the males of the majority of the scale insects.

Under favorable conditions this scale may become destructive, and wherever they seem to be multiplying it would be advisable to use on them the same measures recommended for the San Jose scale.

COTTONY MAPLE SCALE.

(Pulvinaria innumerabilis, Rathvon.)

During the past two years the cottony maple scale has killed many trees in Indiana. It has not been confined to maples entirely, for trees of several other genera have been attacked and killed. Little or no attention has been paid to it in spite of its deadly character. People must become acquainted with these things very intimately before they will "loosen up" with the necessary cash to successfully control them.

Life History.—After hibernating on the twigs of trees all winter, the female lays large quantities of eggs in May and June. It is at this season that the scale is most conspicuous, clinging to the under side of the twigs and surrounded at one end with great masses of cottony padding, which is developed from the body, simultaneously with the eggs. This cottony substance is persistent on the branches through the summer and until worn off by wind and rain.

The eggs hatch in a short time and the young at once migrate to the leaves, where they attach themselves in rows along the veins and begin feeding. They grow rapidly and as summer advances the males and females are differentiated, the males developing wings. At the approach of fall the fertilized females attach themselves to the under sides of the twigs, where they remain all winter. The male dies at the end of summer.

Treatment.—Winter spraying with the lime-sulphur-salt wash or with whale-oil soap is the best means of controlling the cottony scale.

On affected trees the leaves fall presistently throughout the season, often ending with the death of the tree. These leaves should be carefully raked up and burned, as they are an active source of infection for other trees.

Summer spraying would have to be very thorough to be effective, as every leaf on a badly infected tree is the host of innumerable scales. Sometimes a tree that has been completely stripped of its leaves and seemingly killed will put forth a new set of foliage in the fall, but it is not likely that such a tree could withstand the succeeding winter.

ELM TREE BORER.

(Compsidea tridentata.)

This very destructive beetle first attracted attention in Indiana at Vincennes, where for three years it has been destroying elm trees. During the past season it spread to such an alarming extent that the writer was sent for to see what could be done to check its ravages. Probably half the elms in the city were dead or dying and in all the recently-killed trees active larva could still be found.

The eggs are laid on the bark of the tree by the adult beetle, and as soon as they hatch, the young ones enter the tree and feed on the vital portion just between the bark and the wood. In this way the tree is quickly girdled and dies in a few days. There is absolutely no way of checking the pest when it once gets started in a tree, and the only thing to do is to chop the tree off close to the ground and burn it, thus killing all of the contained larva and preventing the further spread of the insect. Where this treatment is followed the beetle can be completely eradicated. In Vincennes, owing to the vigorous measures of Mayor Green, the city will no doubt be free from the pest in a short time. It will, however, take some time to determine whether the treatment has been complete.

This beetle is one of the most dangerous insects with which we have to cope, owing to the fact that its presence is unsuspected

No. 32.

until the tree begins to cast its leaves—and then it is past saving. All dead or dying elms even suspected of containing Compsidea larva should be burned; there is absolutely no other way to exterminate this deadly pest.

In Vincennes it was noted that the trees that had been weakened by trimming were the first to be attacked. This will be found to be true in all cases of insect depredations, and is conclusive proof that a trimmed tree is weaker than one allowed to grow naturally. (See Fig. No. 32.)

ELM LEAF BEETLE.

(Galerucella luteola, Mull.)

An insect to be watched for and guarded against is the imported elm leaf beetle, introduced into this country many years ago from France. Both adults and larva work great damage to the elm trees, especially the European variety, by eating the leaves and destroying the plant's power to care for itself. The operations of this insect are not of a nature to kill the trees directly, as the elm tree borer does, but repeated denudation of foilage is bound ultimately to have a disastrous effect. For this reason treatment should be prompt, so as to retain as much uninjured foliage as possible.

Life History.—The small brownish beetles lay their eggs in spring, on the young growing sprouts of the elm. In six to eight days the eggs hatch and the young (nearly black) larva at once begin to feed on the tender leaves. The larva is full grown in two or three weeks, attaining a length of half an inch. As the larva reaches maturity it develops yellow markings, until the pupa (resting state) is of a uniform yellow color. The insect remains in the resting state (pupa) for about a week when it changes to the adult beetle. The adults also feed on the leaves but not to the extent that the larva do. A difference, too, will be noticed in the methods of eating of the two stages. The larva eat only the surface of the leaf, leaving a network of veins, the adult eats the entire leaf substance, making holes entirely through the leaf. When changing into the pupa stage the larvae always seek the ground, gathering in great numbers about the base of the tree. At this time they can often be killed with hot water, or gathered up and burned.

The most effective treatment throughout the East has been to spray the trees with Paris green at the first appearance of the insect in spring. The poisoned leaves are then fatal alike to both the young and the adults. If a rain succeeds the spraying, it must of course be repeated.

ELM LEAF CATERPILLAR.

(Vanessa antiopa.)

It is not strange that such a common and widely distributed butterfly as the Camberwell beauty should possess such vigor and power of adaptation as to make it a dangerous enemy of some species of plant life. This insect, whose scientific name is given at the head of this article, is known throughout the north temperate zone. In the United States it is one of our hardiest butterflies, hibernating in winter and coming out of its place of hiding on the first warm day in spring. Even in the latitude of Indianapolis they have been noted during mild winters every month of the year.

The caterpillar of the butterfly, it will be understood, is the first stage, after the egg, in the development of the adult insect. It corresponds to the "grub" or "larval" stage of the beetle.

Briefly, we may state the life history of either the beetle, butterfly or moth, as follows: Egg, larva (caterpillar), pupa (resting period,) adult. In the case of the butterfly, the mouth parts of the larva and of the adult are entirely different. The mature insect is not supplied with biting jaws, hence the only damage to foliage is done when the insect is in the caterpillar form.

While the name elm leaf caterpillar has been given to this insect, it does not mean that no other trees are attacked. It is known to have damaged trees of many other species, but its favorite food plants seem to be the elm, poplar and willow trees, with perhaps a preference for the first.

Time of Appearance.—The adult butterfly, having hibernated through the winter, appears on the first warm days of spring and as the leaves of its favorite plants begin to develop it lays its eggs near the tender foliage. The small black caterpillars emerge in from fourteen to seventeen days, and at once crawl to the nearest leaf and begin feeding. In their feeding they are very characteristic, ranging themselves side by side, as many as possible on the same leaf and eating from the edge inward. This habit of colonization makes it usually an easy matter to exterminate a brood before they have developed far enough to cause much damage. If they have not covered too large an area before being discovered it will be found best to cut off the limbs they are on and crush or burn the caterpillars. Where any considerable extent of tree surface is affected a coal oil torch will be convenient to burn them off of the tree, taking care to kill any uninjured ones that fall to the ground.

Spraying with Paris green is also effective in stopping the attack of this or any other caterpillar, but in this case at least, burning seems to be the best and least troublesome method of dealing with the pest. The larva of Vanessa antiopa may be recognized by its dark color and spiny projections on its body and by its characteristic feeding habit, as noted above. When full grown it reaches a length of about one and a quarter inches. The adult, a handsome purplish brown butterfly with wings margined with cream color, has a wing expanse of about three inches.

INSECTICIDES AND THEIR PREPARATION.

Insecticides may be divided into two general classes: Those that kill by external contact, and those that are direct internal poisons. The latter class contains such preparations as Paris green, used only in fighting insects that eat the entire vegetable substance. These internal poisons are not effective against any insect that draws its substance from the interior of the plant as the scale insects and plant lice do. A clear understanding of this difference will prevent the mistake of using an internal poison when an external one is indicated.

Of the external poisons the most important are the lime-sulphur-salt wash and whale-oil soap. A number of patent preparations have recently been put on the market for the treatment of San Jose scale. They all sell at fancy prices and are no more effective than either of the washes mentioned above. Any good seedsman will have an assortment of spray pumps from which the purchaser can make his own selections. There are a number of good ones on the market.

LIME-SULPHUR-SALT WASH.

The following formula is the one used and recommended by the Pacific Coast entomologists:

Good lime	40 pounds
Sulphur	20 pounds
Salt	15 pounds
Water to make	60 gallons

Take 10 pounds of lime and 20 pounds of sulphur, boil with 20 gallons of water for about two hours, or until the sulphur is thoroughly dissolved and the mixture is of deep amber color. While boiling, the liquid must be stirred frequently. Next, place in a cask the rest of the lime and pour enough water over it to thoroughly slack it, and while it is still boiling add the salt and stir until it is thoroughly dissolved. Then add this to the lime and sulphur solution in the boiler and boil for another hour. Sufficient water to make 60 gallons should then be added, keeping the mixture well stirred meanwhile. As the solution must be kept well stirred when spraying, it is best to use a pump with an agitator.

This spray is to be used only in the winter, when the leaves are off the trees, and is most effective when applied hot. The trees should first be well pruned, and the spray applied thoroughly, care being taken that no part of the tree, not even one of the smallest twigs, does not receive its coating of the wash.

This is the standard winter wash on the Pacific coast for the San Jose scale. It will also destroy the eggs of the green aphis and the red spider. As a fungicide the mixture has but small value. Some orchardists add concentrated lye to the above solution in the proportion of two or three pounds to the hundred gallons, claiming that the wash is made much more effective thereby. As it is completely effective without the lye, the addition of the latter seems unnecessary, and no careful experiments have yet been made which demonstrate that the lye is a desirable addition.

WHALE-OIL SOAP WASH.

A simple solution of whale-oil soap in water has been found to be one of the most effective things that can be used against the San Jose scale. For spraying it can be prepared by dissolving the soap in hot water in the proportion of 15 pounds of soap to 100 gallons of water. Where whale-oil soap is not obtainable any good strong soap can be used but must be applied in stronger solution than indicated above. When the scale is confined to the trunk and large limbs, a stiff scrubbing brush will be found even more effective than a spray pump in applying soap solutions.

KEROSENE EMULSION.

Kerosene	2 gallons
Whale-oil soap (or 1 quart soft soap)	½ pound
Water	1 gallon

Dissolve the soap in the boiling water and while still hot add to the kerosene, taking care to keep the latter away from the fire. The whole mixture is then violently stirred, preferably by being pumped back on itself through an ordinary one-eighth-inch nozzle. Many forms of spray pumps answer the purpose admirably. After four or five minutes pumping the mixture will have a thick creamy consistency, and if well made will stand indefinitely without free oil rising to the surface.

Unless otherwise stated, the emulsion is to be used dissolved in water in the proportion of one gallon of the emulsion to 15 to 20 gallons of water.

It must be remembered that kerosene is a plant poison as well as an insecticide, and great care should be exercised in applying any wash containing it. Pure kerosene has been used in a few cases, but it is a dangerous experiment and cannot be recommended to the novice in tree spraying.

PARIS GREEN.

Solutions of Paris green should be handled with great care and should always be labeled, as they are violent poisons. Of all the arsenical poisons this one is to be recommended as it is more quickly recognizable by its color.

Paris green	1 pound
Lime	1 pound
Water	150 gallons

Make a fine paste of the Paris green with a small quantity of water, and then add to the lime which has been slacked in a bucket. Pour the mixture through a strainer into the spray tank and add the water.

Thirty Timber Trees of Indiana.

BY BENJ. W. DOUGLASS.

In this list of thirty Indiana trees we have tried to select those possessing the greatest economic value, and, while there may be differences of opinion as to the value of certain species, we feel that there are none described that we would willingly leave out, although there are others we would gladly include if our space permitted. Among them might be mentioned the hackberry, which for some purposes seems equal to white ash; the mulberry, durable in contact with the soil; several varieties of hickory, similar and equal to those described; and the scarlet, swamp white, basket and post oaks, all of which produce excellent timber for various purposes. With the temptation of this auxiliary list it has been difficult to confine ourselves to the chosen thirty woods, but time and space would not permit of the enlarging of our original plan.

The sequence of species adopted in the following arrangement is that of Britton and Brown, whose "Flora of the Northern States and Canada" has been our authority throughout the work.

The maximum measurements given are the authentic records of scientific observers, and if they seem a little large to the botanist of today, it must be remembered that the lower Wabash Valley, where most of the giants grew, was, and is, a wonderfully fertile region where the conditions were exactly right for the development of the finest deciduous forest that the world has ever seen.

The pictures of the trunks are from the most typical specimens it was possible to secure and not, necessarily, from the largest trees encountered in our field work. The diameter measurements of these trunks as given were taken at about four feet from the ground in each case.

Only the most general uses of each kind of timber are given, and it will be understood that the actual use of a species is not confined to the purposes mentioned.

1. Juglans nigra L. (Black Walnut.)
   Diameter of specimen, 24 inches.
   Average height, 120 feet.
   Maximum height, 150 feet; diameter, 8 feet.
   Wood strong, hard and durable; color rich brown; weight per cubic foot, 38 pounds. Uses: Universal where a fine hard or durable wood is desired. The most valuable Indiana wood.

2. Juglans cinera L. (White Walnut.)
   Diameter of specimen, 20 inches.
   Average height, 60 feet.
   Maximum height, 100 feet; diameter, 3 feet.
   Wood soft and weak; color light brown; weight per cubic foot, 25 pounds. Uses: Furniture; interior finish.

3. Hicoria ovata Britton. (Shellbark Hickory.)
   Diameter of specimen, 20 inches.
   Average height, 100 feet.
   Maximum height, 120 feet; diameter, 4 feet.
   Wood strong, tough; color light brown; weight per cubic foot, 52 pounds. Uses: Farm implements, handles, hoops. An excellent, but now expensive, fuel.

4. Hicoria laciniosa Sarg. (King-nut Hickory.)
   Diameter of specimen, 28 inches.
   Average height, 80 feet.
   Maximum height, 120 feet; diameter, 4 feet.
   Wood strong, tough; color darker brown than ovata; weight per cubic foot, 50 pounds. Uses: Identical with Hicoria ovata.

5. Hicoria glabra Britton. (Pig-nut Hickory.)
   Diameter of specimen, 22 inches.
   Average height, 90 feet.
   Maximum height, 120 feet; diameter, 5 feet.
   Wood hard, strong and tough; color dark brown; weight per cubic foot, 51 pounds. Uses: Principally for farm implements.

6. Populus deltoides Marsh. (Cottonwood.)
Diameter of specimen, 28 inches.
Average height, 120 feet.
Maximum height, 150 feet; diameter, 7½ feet.
Wood soft and weak; color dark brown; weight per cubic foot, 24 pounds. Uses: Manufacture of paper pulp, boxes and fencing. Called also Carolina poplar.

7. Fagus Americana Sweet. (Beech.)
Diameter of specimen, 30 inches.
Average height, 70 feet.
Maximum height, 120 feet; diameter, 4½ feet.
Wood hard, strong, tough and close grained; color light red; weight per cubic foot, 43 pounds. Uses: Furniture, farm implements and parquet flooring.

8. Castanea dentata Borkh. (Chestnut.)
Diameter of specimen, 20 inches.
Average height, 80 feet.
Maximum height, 100 feet; diameter, 14 feet.
Wood durable, coarse grained; color brown; weight per cubic foot, 28 pounds. Uses: Furniture, interior finish, railroad ties and fencing.

9. Quercus rubra L. (Red Oak.)
Diameter of specimen, 33 inches.
Average height, 100 feet.
Maximum height, 140 feet; diameter, 7 feet.
Wood hard, strong, and coarse grained; color light reddish brown; weight per cubic foot, 41 pounds. Uses: Furniture, construction, interior finish.

10. Quercus palustris Du Roi. (Pin Oak.)
Diameter of specimen, 30 inches.
Average height, 80 feet.
Maximum height, 120 feet; diameter, 5 feet.
Wood hard, very strong and coarse grained; color light brown; weight per cubic foot, 43 pounds. Uses: Construction.

11. Quercus velutina Lam. (Black Oak.)
Diameter of specimen, 30 inches.
Average height, 100 feet.
Maximum height, 150 feet; diameter, 5 feet.
Wood reddish brown; hard, strong and coarse grained; weight per cubic foot, 43 pounds. Uses: Cooperage and building.

12. Quercus alba L. (White Oak.)
Diameter of specimen, 28 inches.
Average height, 120 feet.
Maximum height, 150 feet; diameter, 8 feet.
Wood hard, strong, tough and close grained; color brown; weight per cubic foot, 46 pounds. Uses: Ship building, farm implements, cabinet making, interior finish. The best of all the oaks.

13. Quercus macrocarpa Michx. (Burr Oak.)
Diameter of specimen, 36 inches.
Average height, 130 feet.
Maximum height, 160 feet; diameter, 8 feet.
Wood hard, strong, tough, close grained; color dark brown; weight per cubic foot, 46 pounds. Nearly or quite equal to Q. alba in quality and used for the same purposes.

14. Quercus prinus L. (Rock Chestnut Oak.)
Diameter of specimen, 20 inches.
Average height, 80 feet.
Maximum height, 100 feet; diameter, 5 feet.
Wood hard, strong, close grained, durable; color dark brown; weight per cubic foot, 47 pounds. Uses: Similar to Q. alba.

15. Quercus acuminata Sarg. (Chinquapin Oak.)
Diameter of specimen, 24 inches.
Average height, 125 feet.
Maximum height, 160 feet; diameter, 3½ feet.
Wood hard, dense, close grained, durable; color dark brown; weight per cubic foot, 54 pounds. Uses: Cooperage, wheels, fencing, railroad ties.

16. Ulmus Americana L. (American Elm.)
Diameter of specimen, 30 inches.
Average height, 100 feet.
Maximum height, 120 feet; diameter, 11 feet.
Wood hard, strong, close grained, compact; color dark brown; weight per cubic foot, 40.5 pounds. Uses: Hubs, cooperage; will polish for furniture uses.

17. Ulmus fulva Michx. (Slippery Elm.)
Diameter of specimen, 26 inches.
Average height, 60 feet.
Maximum height, 80 feet; diameter, 3½ feet.
Wood hard, heavy, tough and durable; color brown; weight per cubic foot, 43.35 pounds. Uses: Farm implements, railroad ties, fencing; flexible when steamed.

18. Liriodendron tulipifera L. (Yellow Poplar.)
Diameter of specimen, 26 inches.
Average height, 150 feet.
Maximum height, 190 feet; diameter, 12 feet.
Wood soft, yellowish in color; weight per cubit foot, 26 pounds. Uses: Building, pattern making, wooden ware. One of our largest trees. Not a poplar at all, but a member of the Magnolia family, commonly called the tulip tree.

19. Platanus occidentalis L. (Sycamore.)
Diameter of specimen, 28 inches.
Average height, 120 feet.
Maximum height, 130 feet; diameter, 14 feet.
Wood hard, difficult to split; color reddish brown; weight per cubic foot, 35 pounds. Uses: Furniture, interior finish. The largest tree of East America.

20. Prunus serotina Ehrh. (Wild Black Cherry.)
Diameter of specimen, 24 inches.
Average height, 75 feet.
Maximum height, 90 feet; diameter, 4 feet.
Wood hard, strong; color reddish brown; weight per cubic foot, 36 pounds. Uses: Interior finish and cabinet work. Takes a fine polish.

21. Gleditsia triacanthos L. (Honey Locust.)
    Diameter of specimen, 20 inches.
    Average height, 80 feet.
    Maximum height, 140 feet; diameter, 5½ feet.
    Wood durable, hard and strong; color bright reddish brown; weight per cubic foot, 42 pounds. Uses: Fence posts and railroad ties.

22. Gymnocladus dioica Koch. (Coffee Tree.)
    Diameter of specimen, 26 inches.
    Average height, 80 feet.
    Wood soft, strong and durable; color light reddish brown; weight per cubic foot, 43 pounds. Uses: Fence posts and railroad ties.

23. Robinia pseudăcacia L. (Black Locust.)
    Diameter of specimen, 28 inches.
    Average height, 60 feet.
    Maximum height, 80 feet; diameter, 3½ feet.
    Wood hard, strong, and very durable; color greenish brown; weight per cubic foot, 46 pounds. Uses: Fence posts and railroad ties.

24. Acer rubrum L. (Red Maple.)
    Diameter of specimen, 30 inches.
    Average height, 90 feet.
    Maximum height, 120 feet; diameter, 4½ feet.
    Wood hard, not strong; color light reddish brown; weight per cubic foot, 38 pounds. Uses: Chiefly for cabinet work.

25. Acer saccharum Marsh. (Sugar Maple.)
    Diameter of specimen, 38 inches.
    Average height, 90 feet.
    Maximum height, 120 feet; diameter, 3½ feet.
    Wood hard, strong; color yellowish brown; weight per cubic foot, 43 pounds. Uses: Interior finish, furniture; takes a high polish. Occasionally occurs as "birds-eye maple."

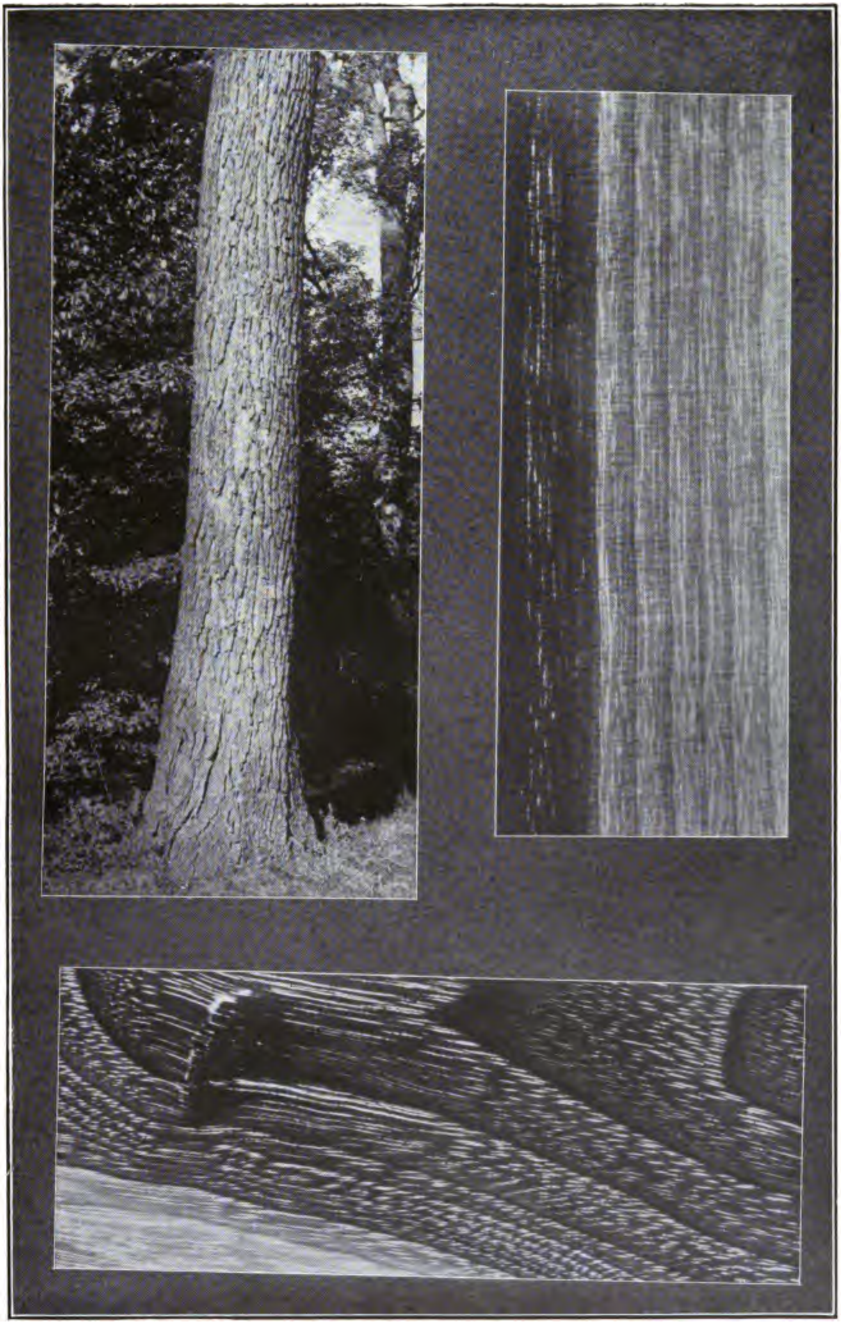
26. Acer nigrum Michx. (Black Sugar Maple.)
Diameter of specimen, 24 inches.
Average height, 70 feet.
Maximum height, 120 feet; diameter, 3½ feet.
Wood similar to preceding. Acer Saccharum and A. nigrum are the two chief sources of maple sugar. A. nigrum is sometimes considered a variety of the former.

27. Tilia Americana L. (Linden.)
Diameter of specimen, 28 inches.
Average height, 80 feet.
Maximum height, 125 feet; diameter, 5 feet.
Wood soft and weak; color light brown; weight per cubic foot, 28 pounds. Uses: Woodenware, furniture, fishing rods.

28. Fraxinus Americana L. (White Ash.)
Diameter of specimen, 33 inches.
Average height, 100 feet.
Maximum height, 130 feet; diameter, 6 feet.
Wood hard, strong and tough; weight per cubic foot, 41 pounds. Uses: Farm implements, furniture and oars.

29. Fraxinus nigra Marsh. (Black Ash.)
Diameter of specimen, 32 inches.
Average height, 80 feet.
Maximum height, 100 feet; diameter, 3 feet.
Wood soft, not strong; color dark brown; weight per cubic foot, 39 pounds. Uses: Hoops, baskets and interior finish.

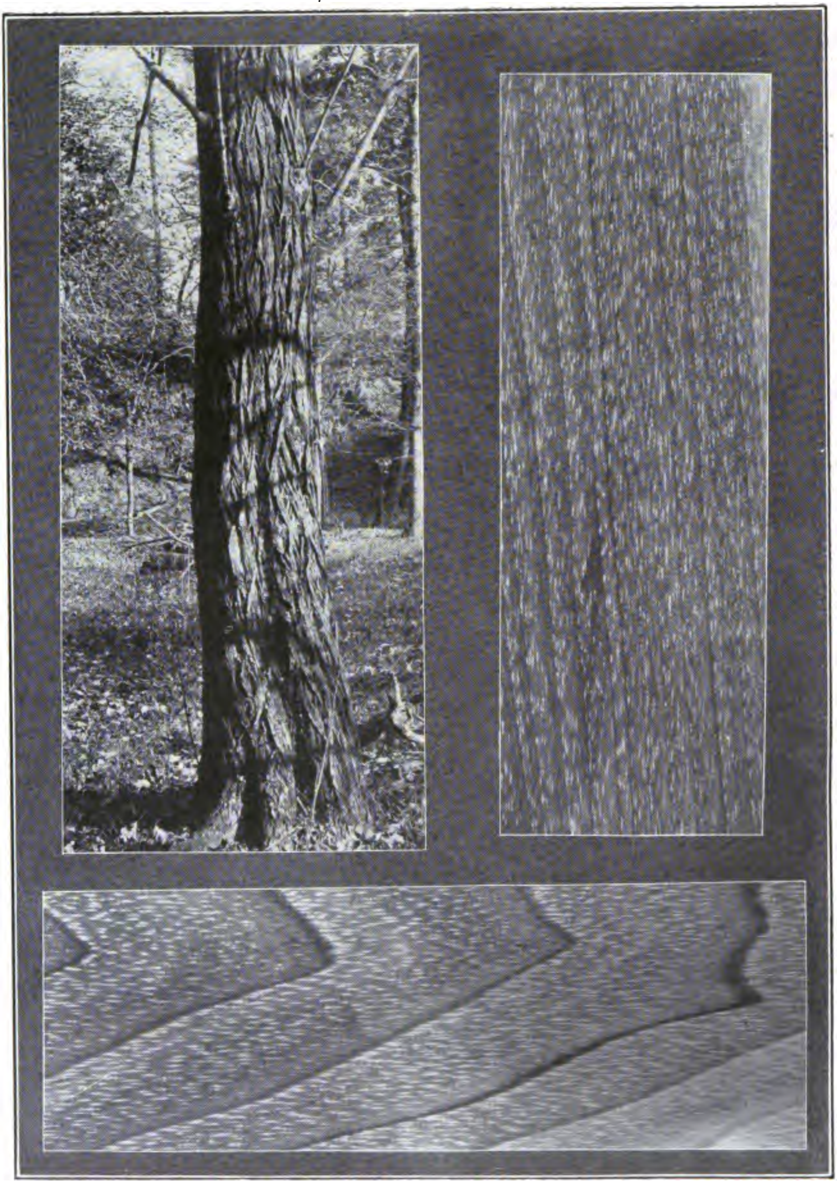
30. Catalpa speciosa Warder. (Catalpa.)
Diameter of specimen, 20 inches.
Average height, 60 feet.
Maximum height, 120 feet; diameter, 4½ feet.
Wood soft and weak but durable; color brown; weight per cubic foot, 26 pounds. Uses: Fence posts and railroad ties.



No. 1. Black walnut.

Body of tree. Longitudinal section.

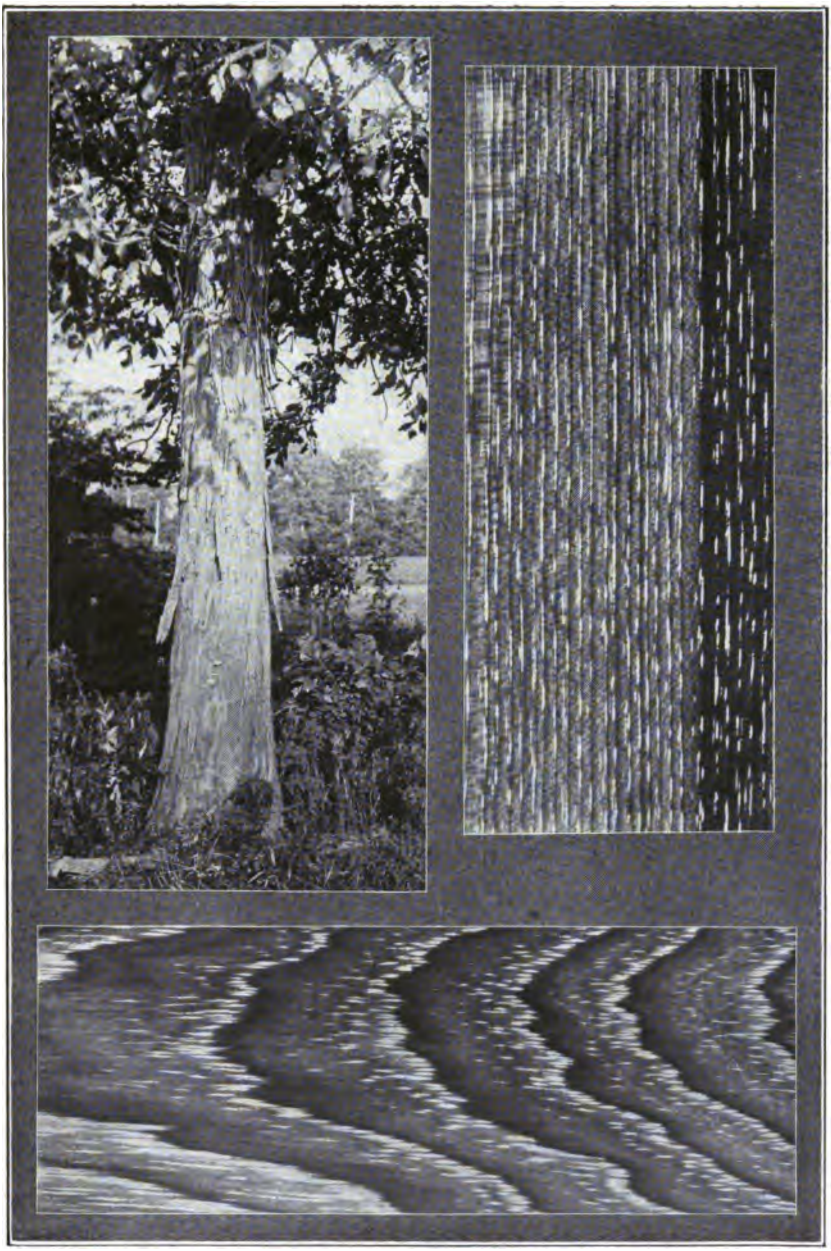
Tangential section.



No. 2. Butternut.

Body of tree. Longitudinal section.

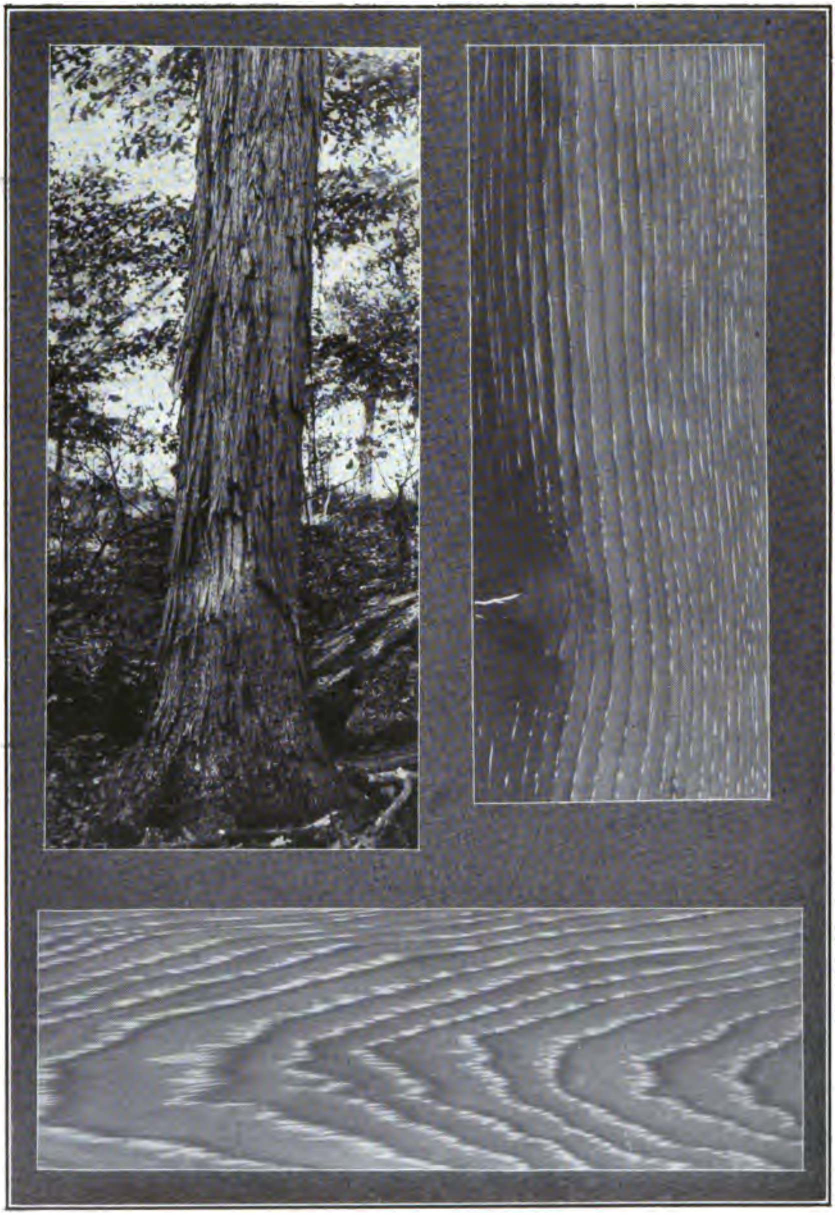
Tangential section.



No. 3. Shellbark hickory.

Body of tree. Longitudinal section.

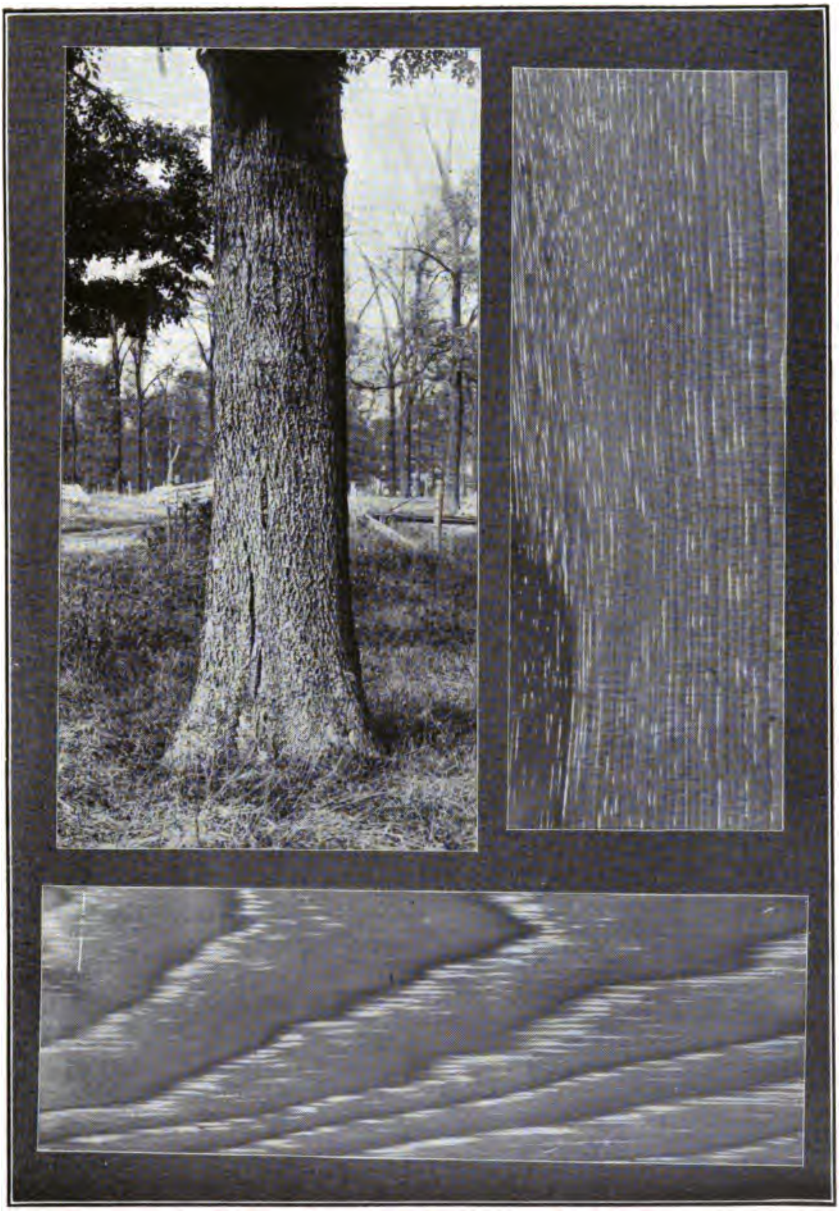
Tangential section.



No. 4. King hickory nut.

Body of tree. Longitudinal section.

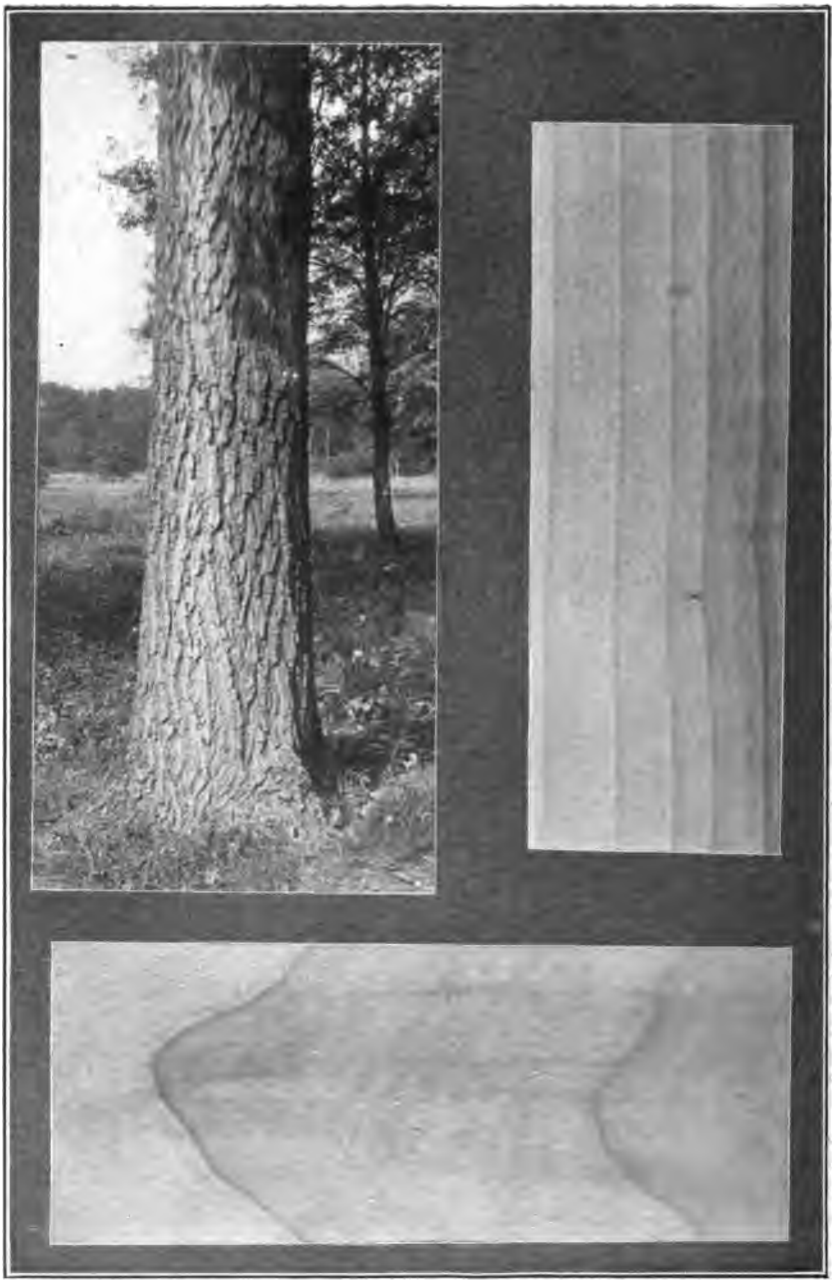
Tangential section.



No. 5. Pig hickory nut.

Body of tree. Longitudinal section.

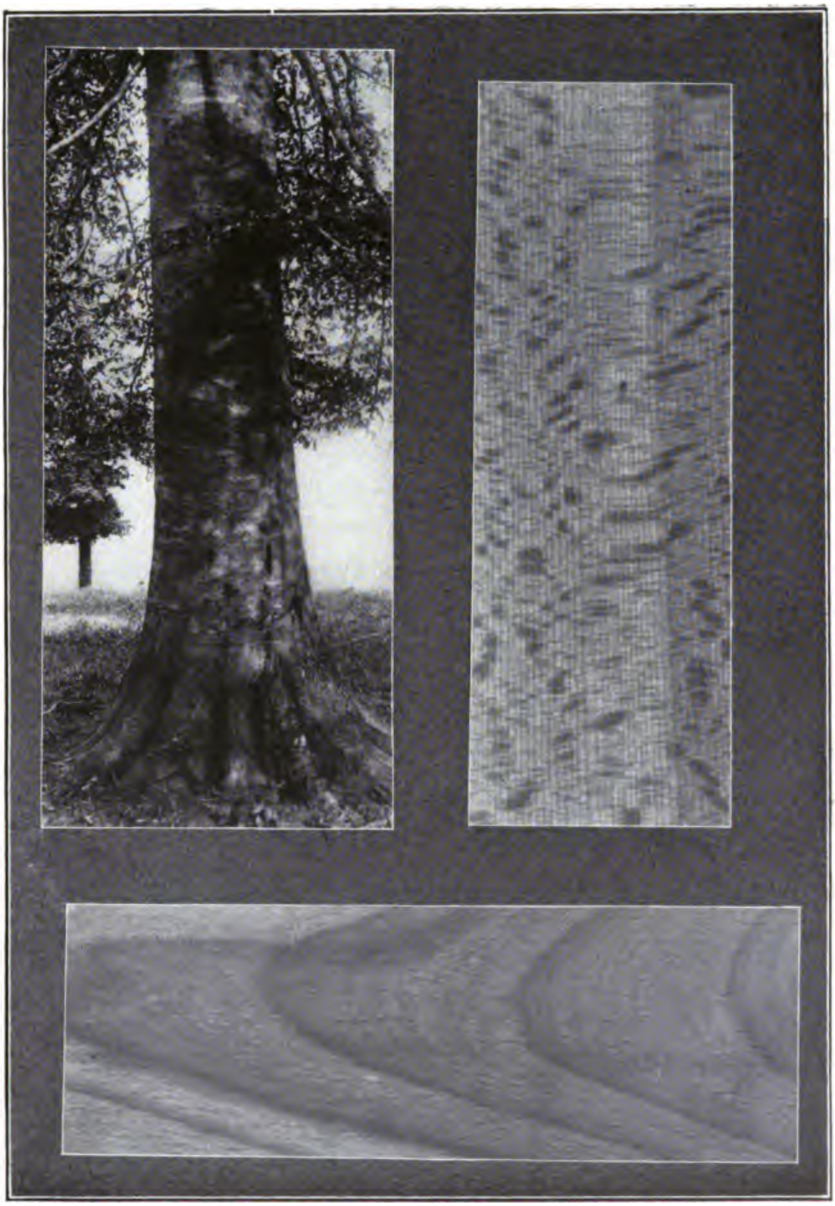
Tangential section.



No. 6. Cottonwood.

Body of tree. Longitudinal section.

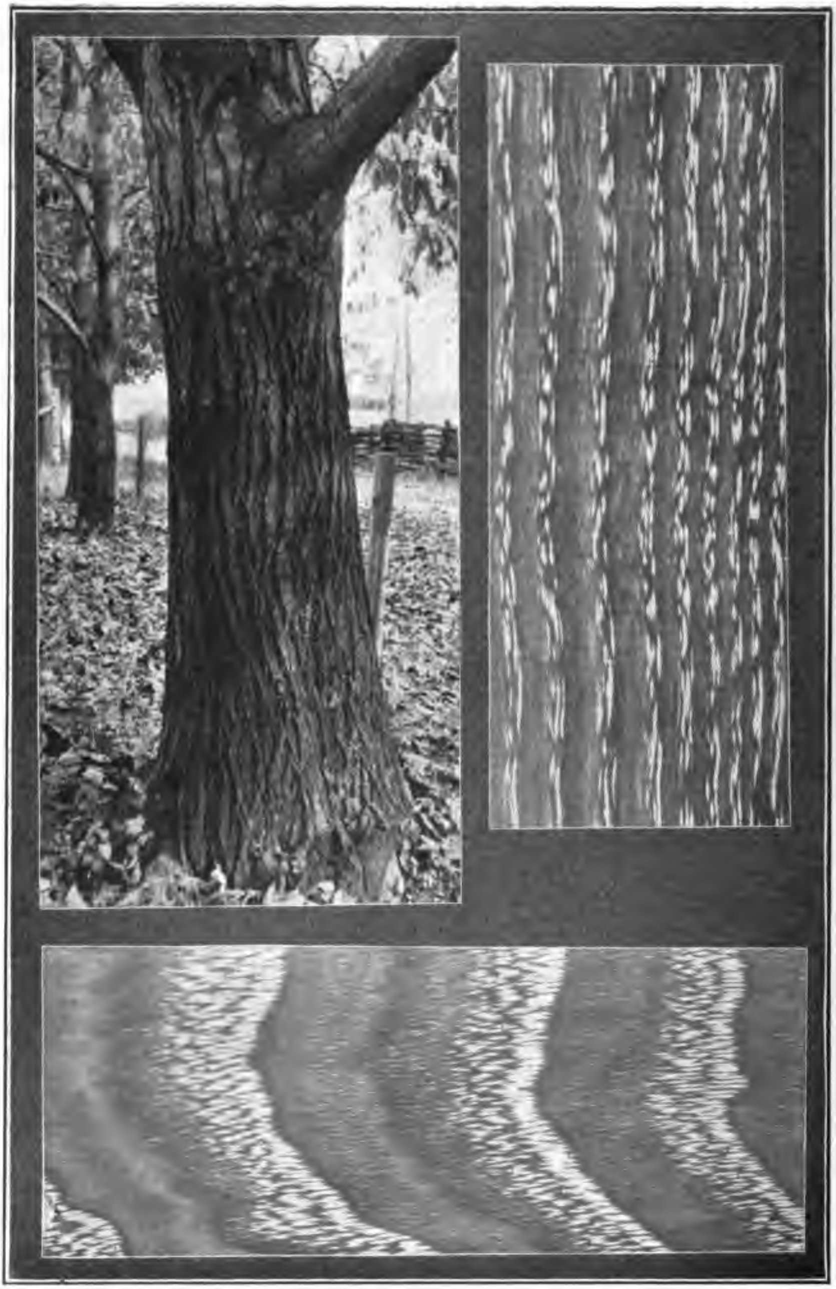
Tangential section



No. 7. Beech.

Body of tree. **Longitudinal section.**

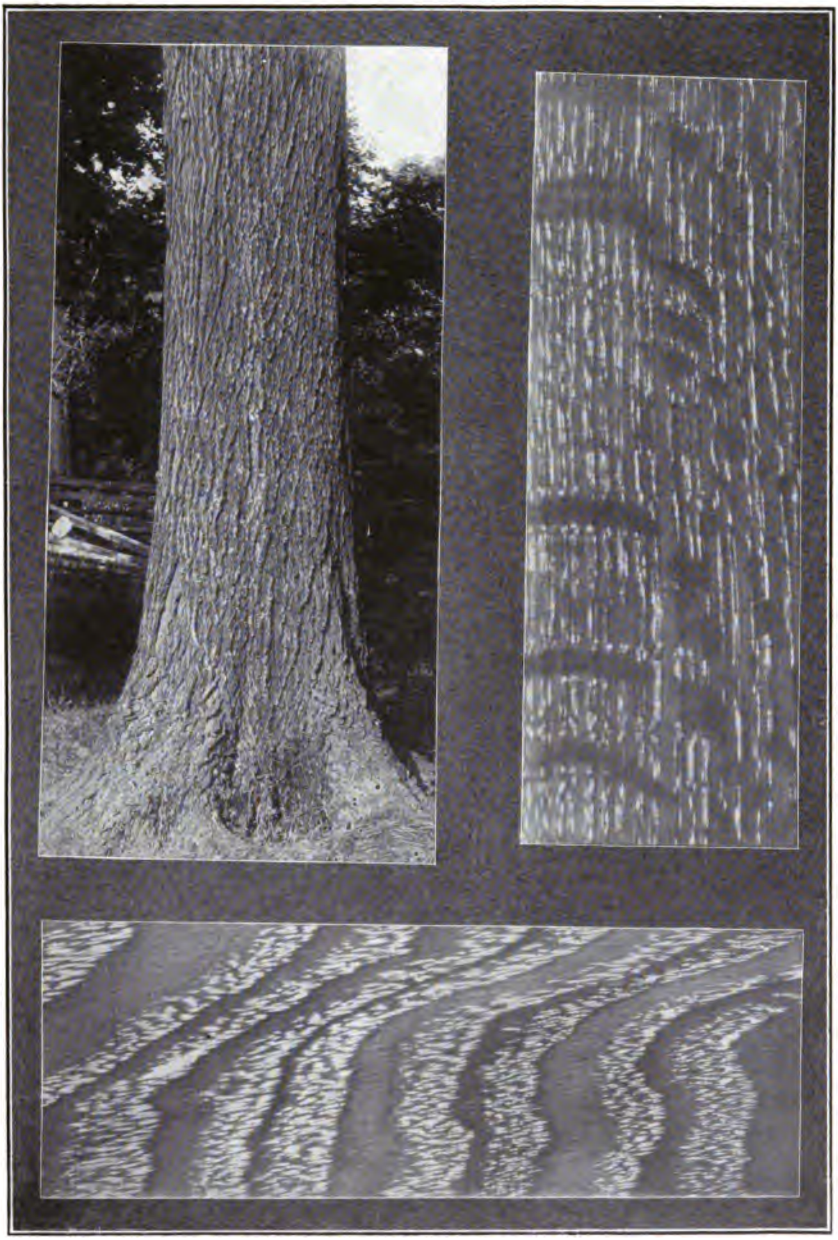
Tangential section.



No. 8. Chestnut.

Body of tree. Longitudinal section.

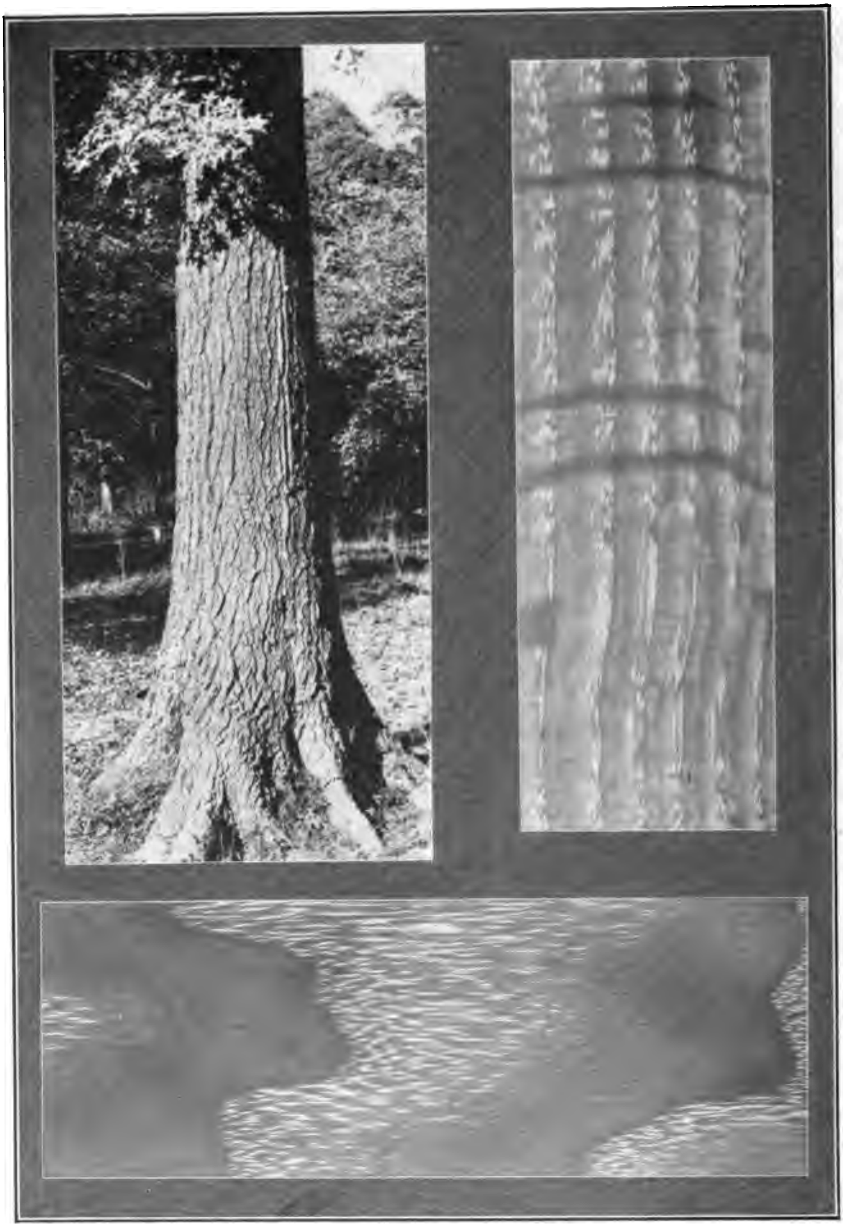
Tangential section.



No. 9. Red oak.

Body of tree. Longitudinal section.

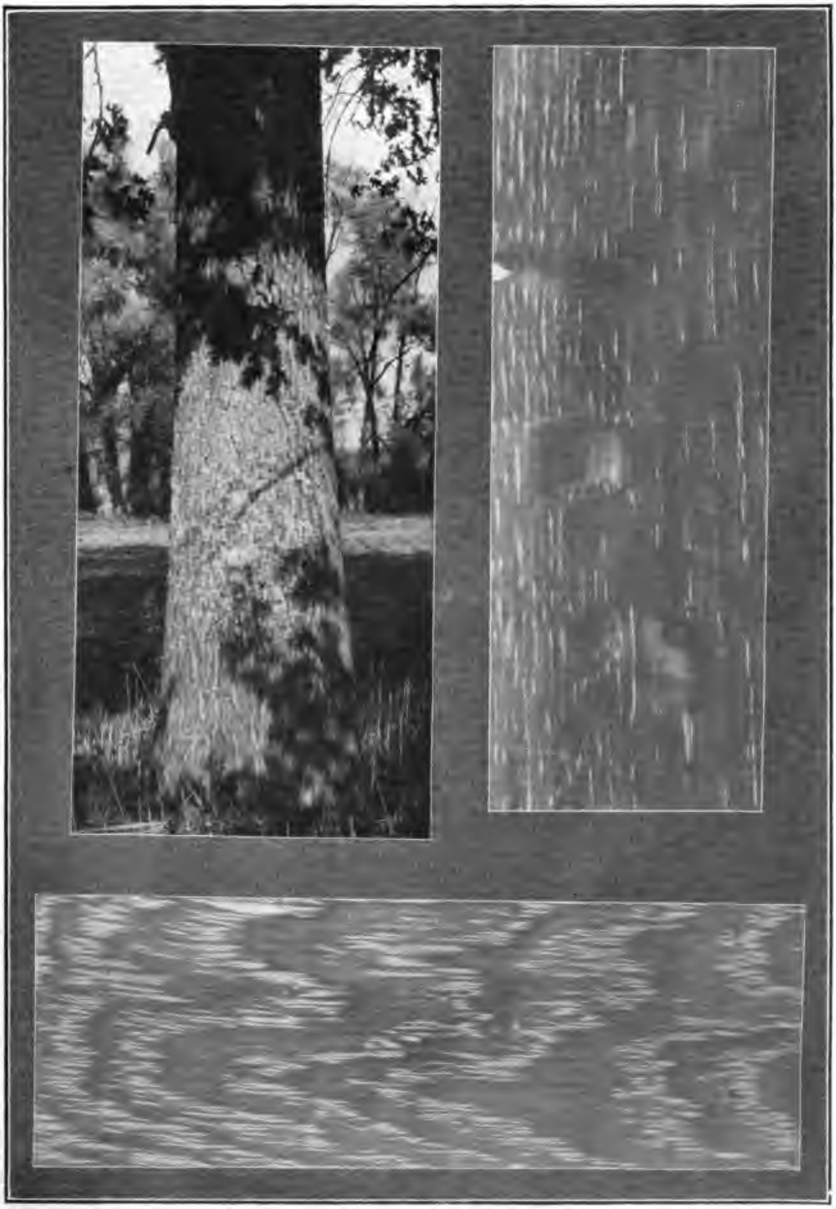
Tangential section.



No. 10. Pin oak.

Body of tree. Longitudinal section.

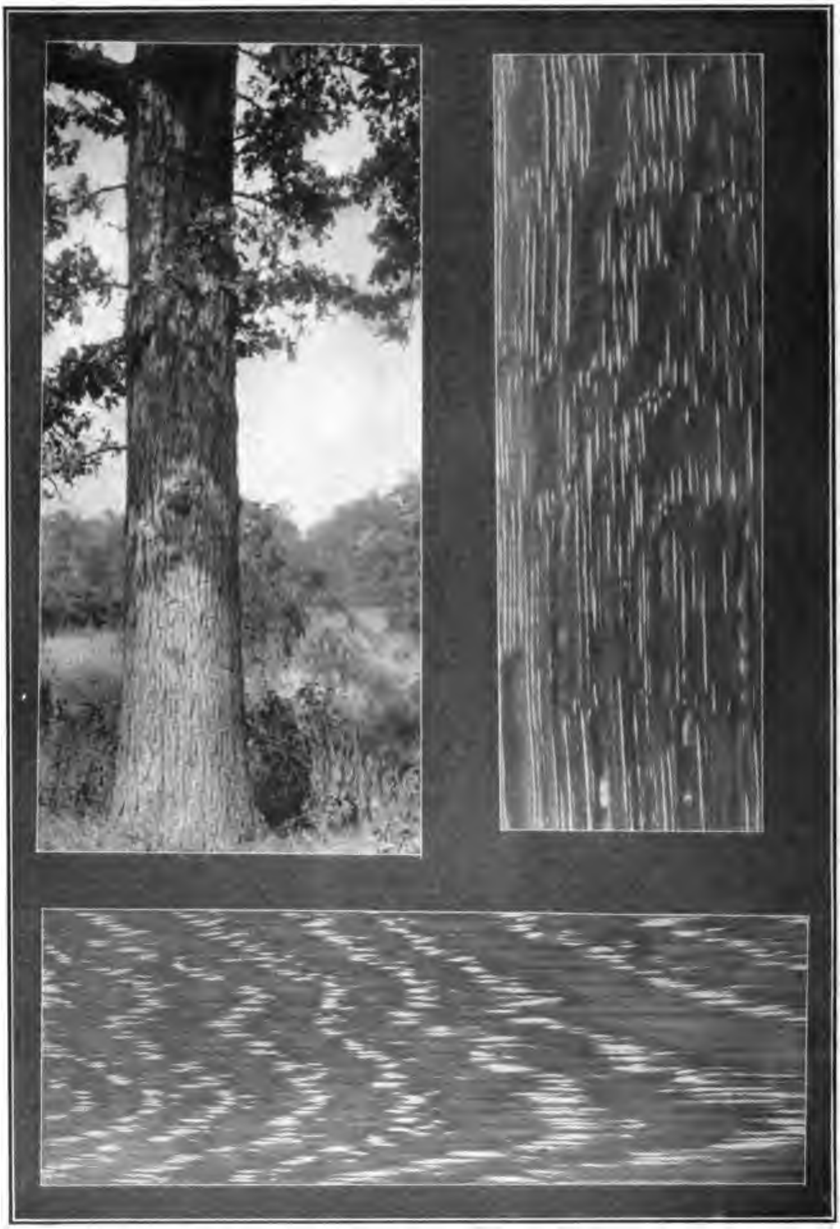
Tangential section.



No. 11. Black oak.

Body of tree. Longitudinal section.

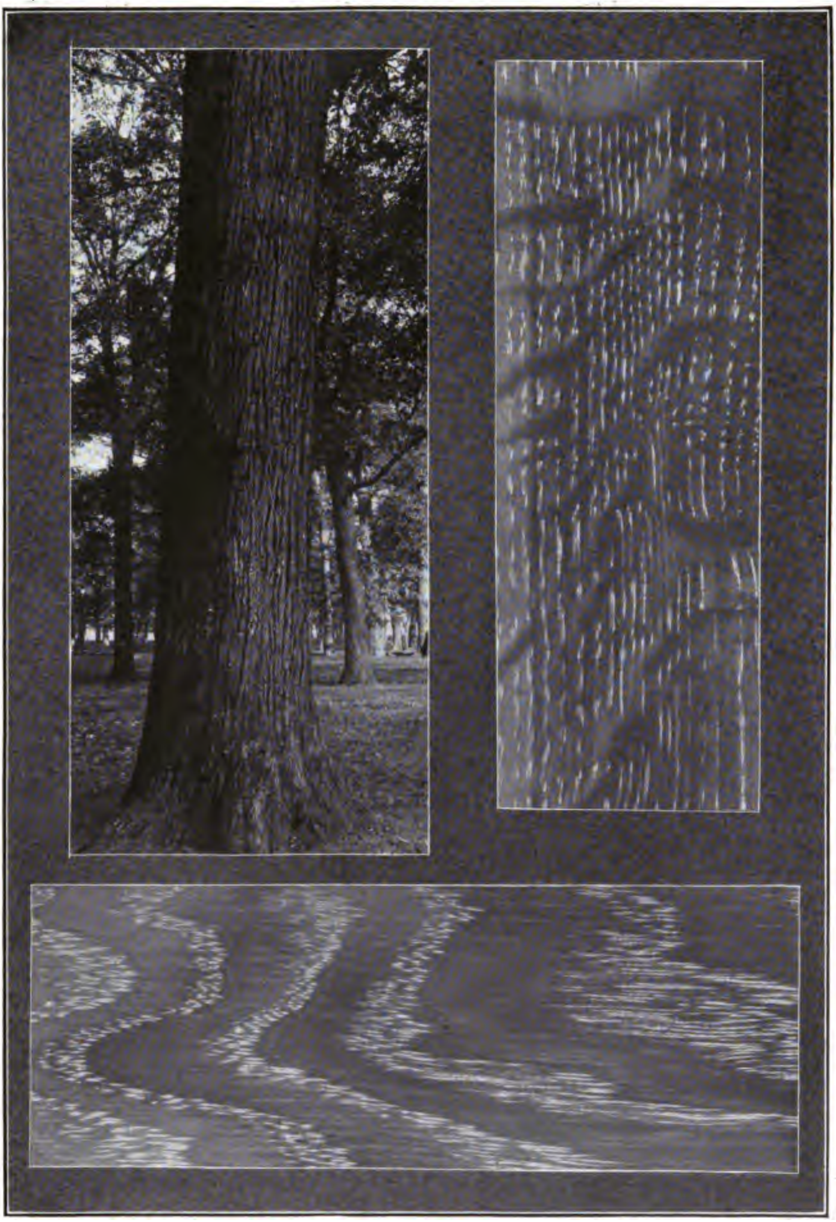
Tangential section.



No. 12. White oak.

Body of tree. Longitudinal section.

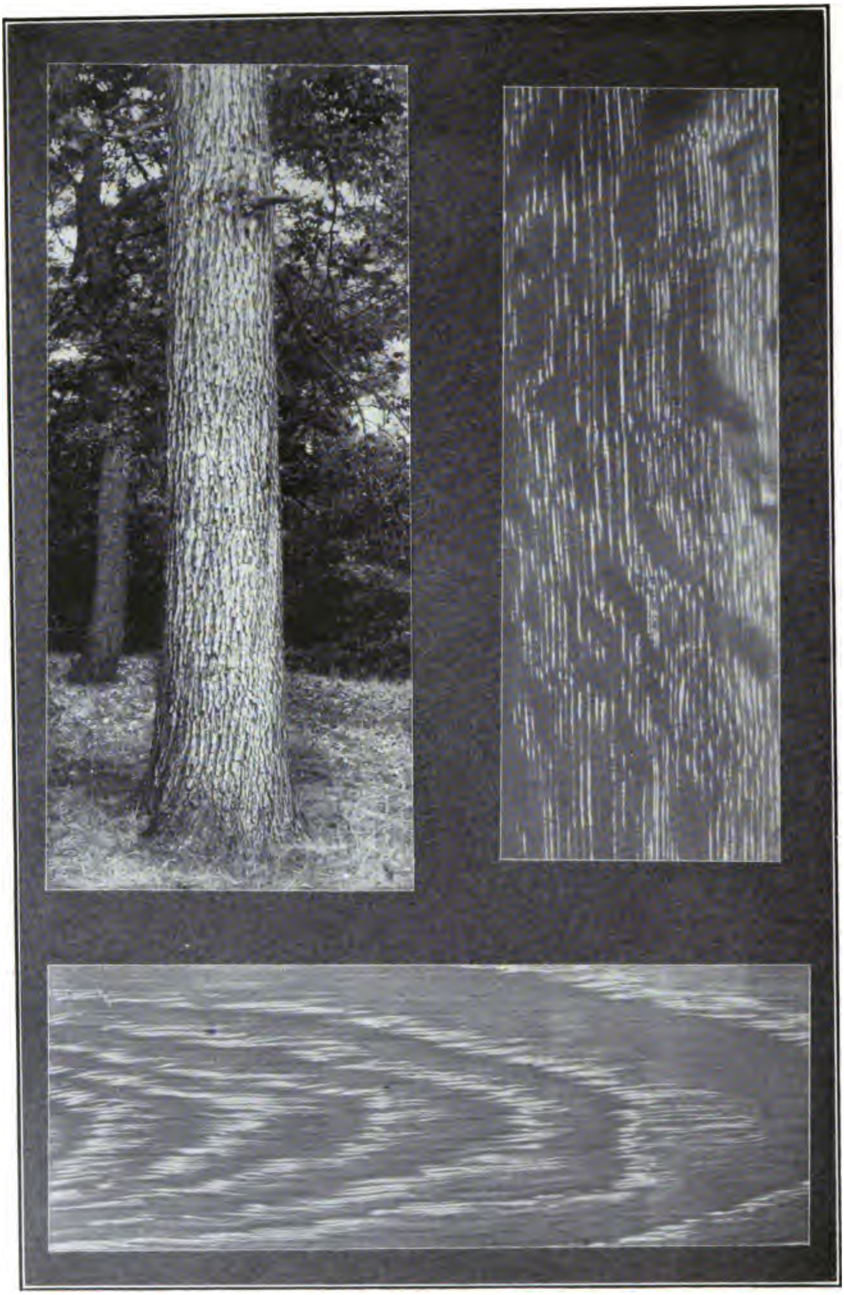
Tangential section.



No. 13. Burr oak.

Body of tree. Longitudinal section.

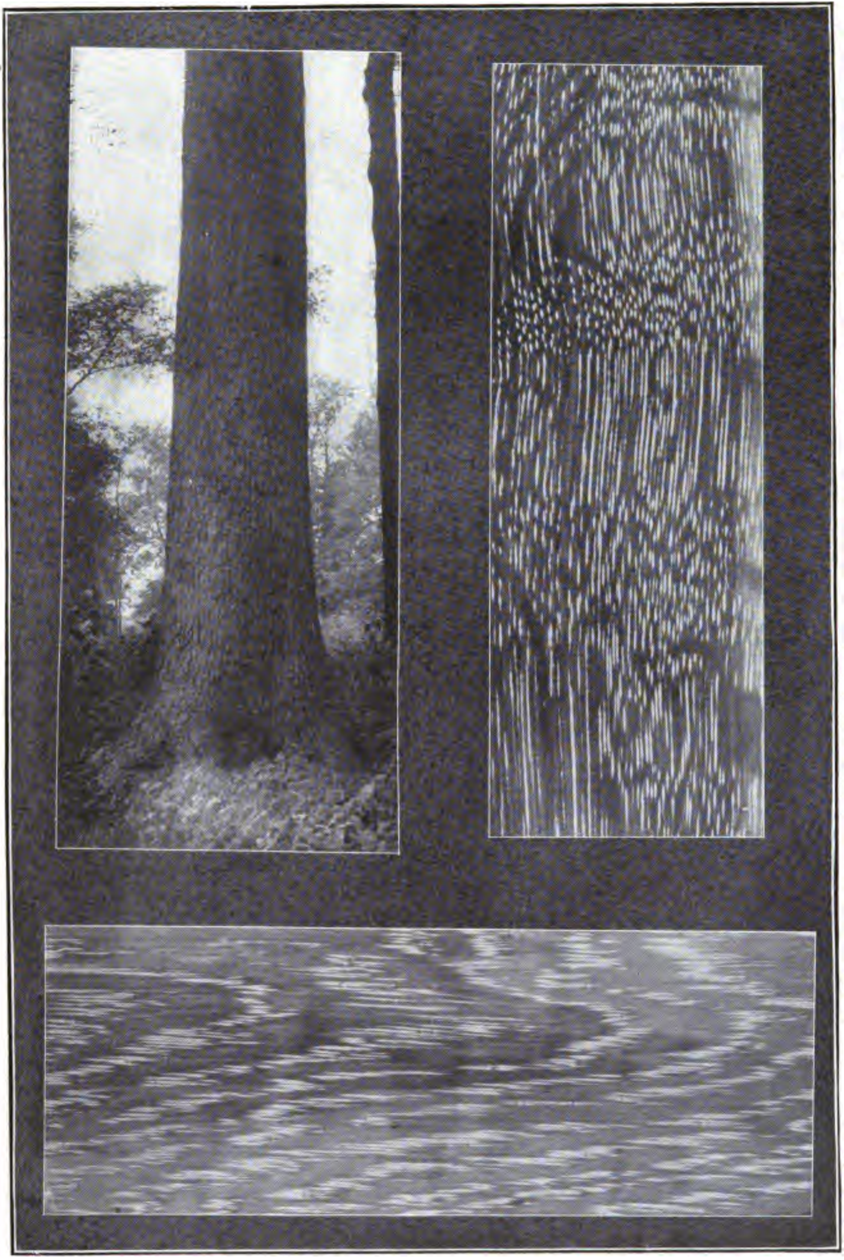
Tangential section.



No. 14. Rock chestnut oak.

Body of tree. Longitudinal section.

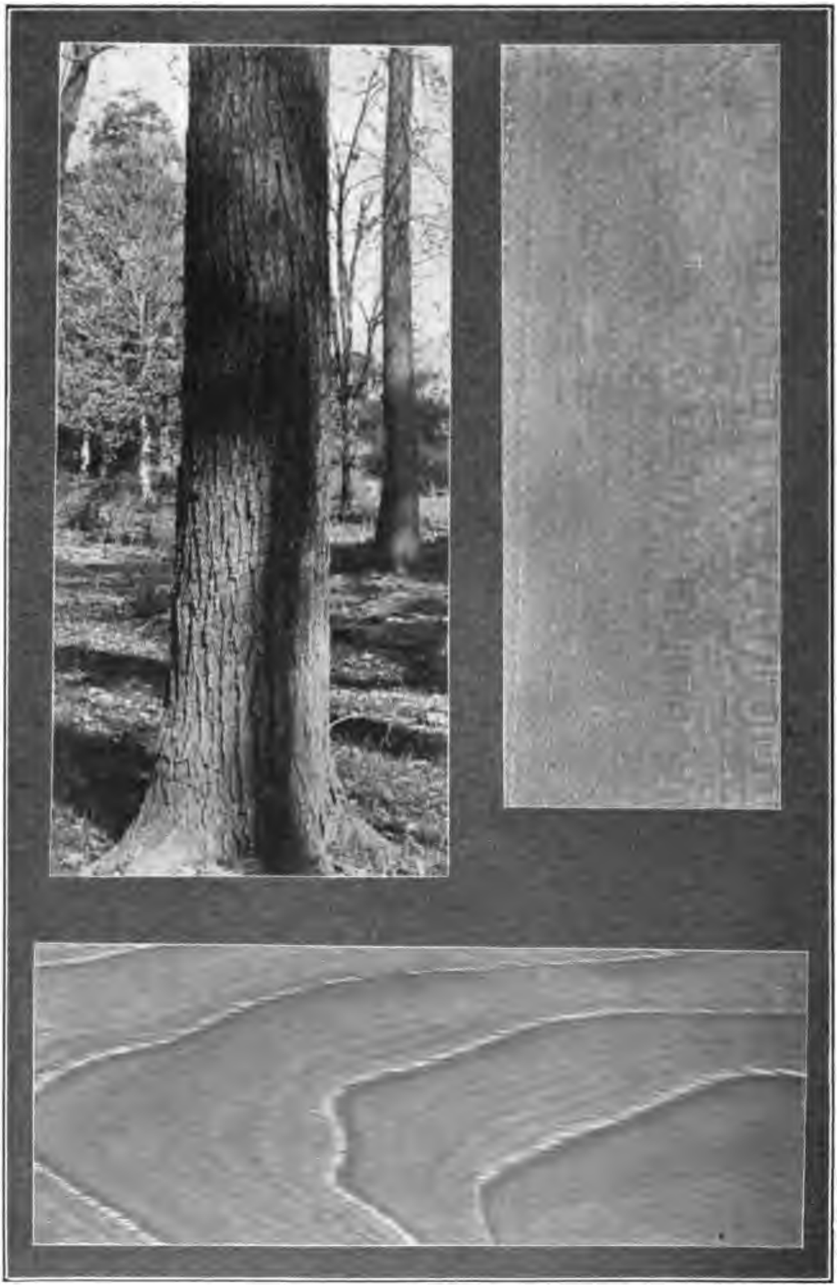
Tangential section.



No. 15. Chinquapin oak.

Body of tree. Longitudinal section.

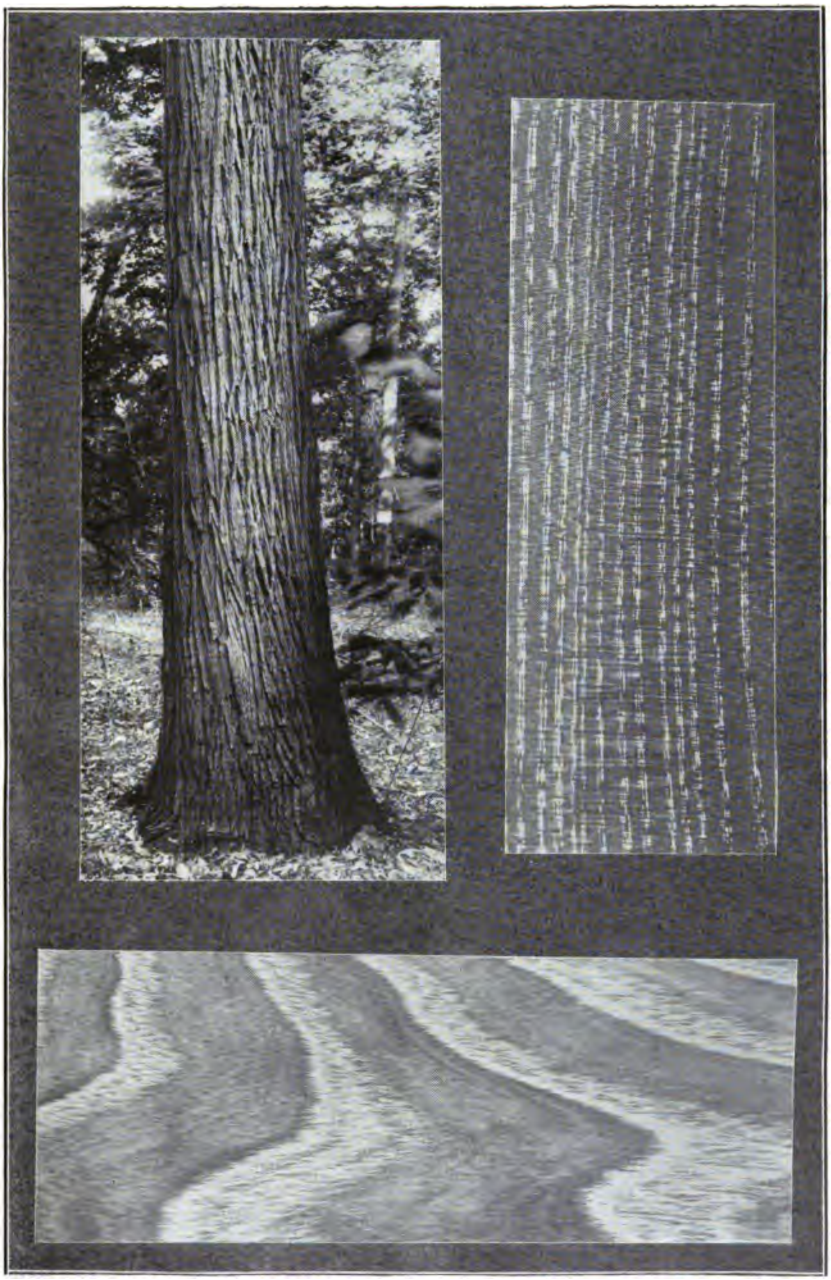
Tangential section.



No. 16. American elm.

Body of tree. Longitudinal section.

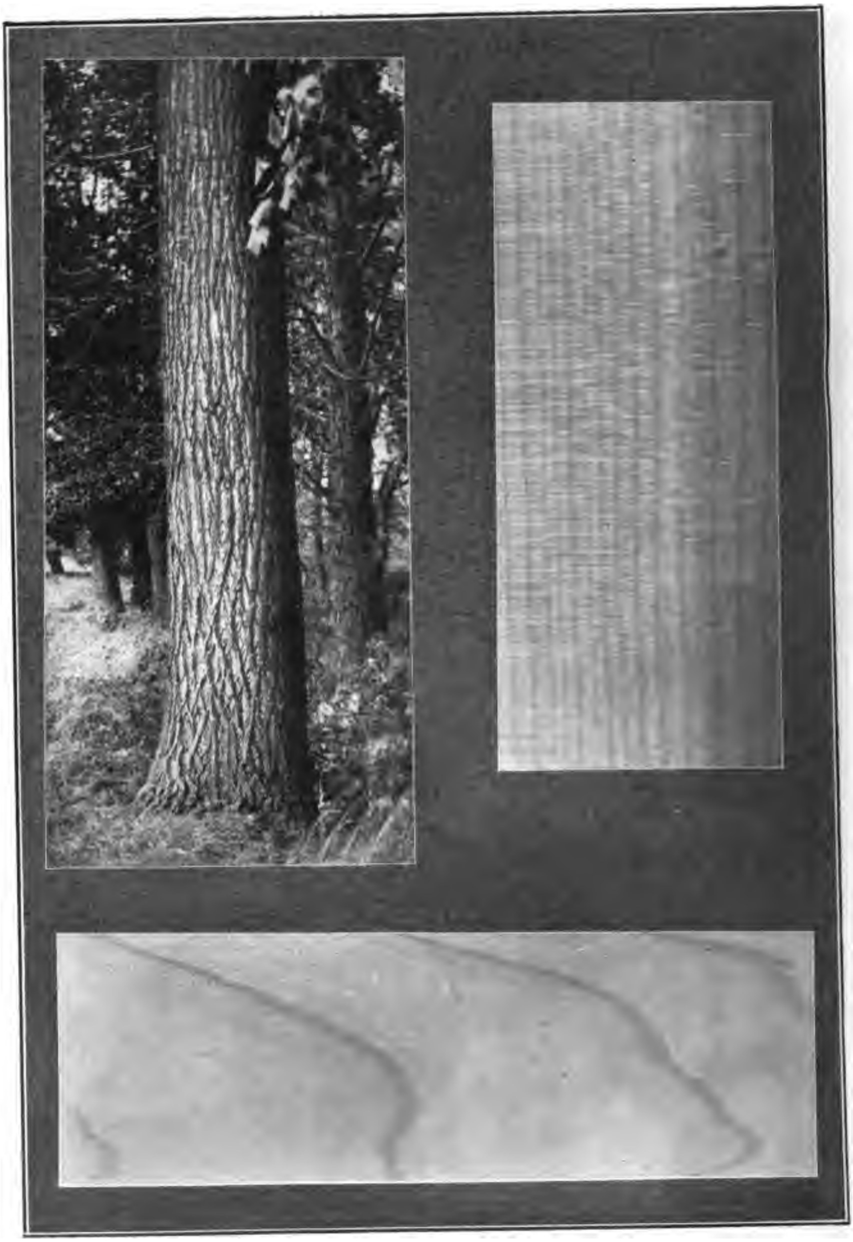
Tangential section.



No. 17. Slippery elm.

Body of tree. Longitudinal section.

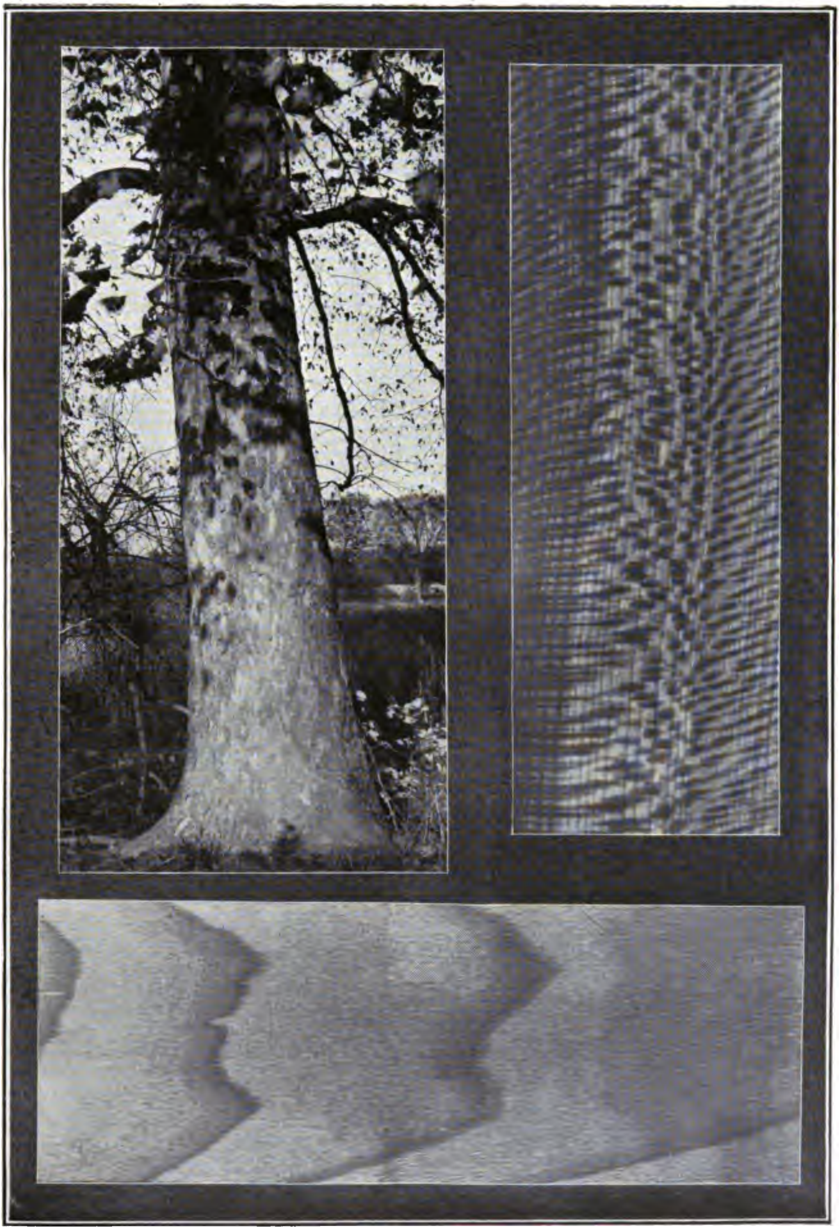
Tangential section.



No. 18. Yellow poplar.

Body of tree. Longitudinal section.

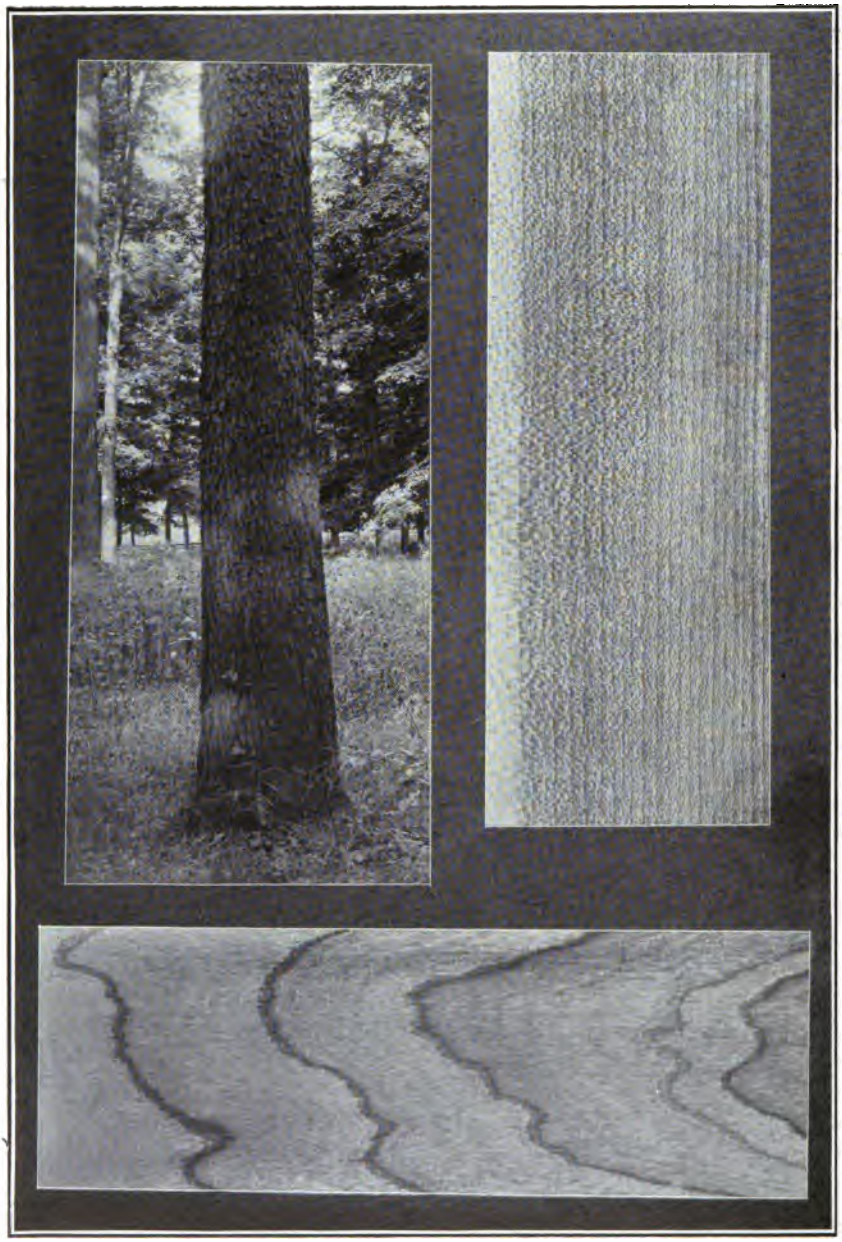
Tangential section.



No. 19. Sycamore.

Body of tree. Longitudinal section.

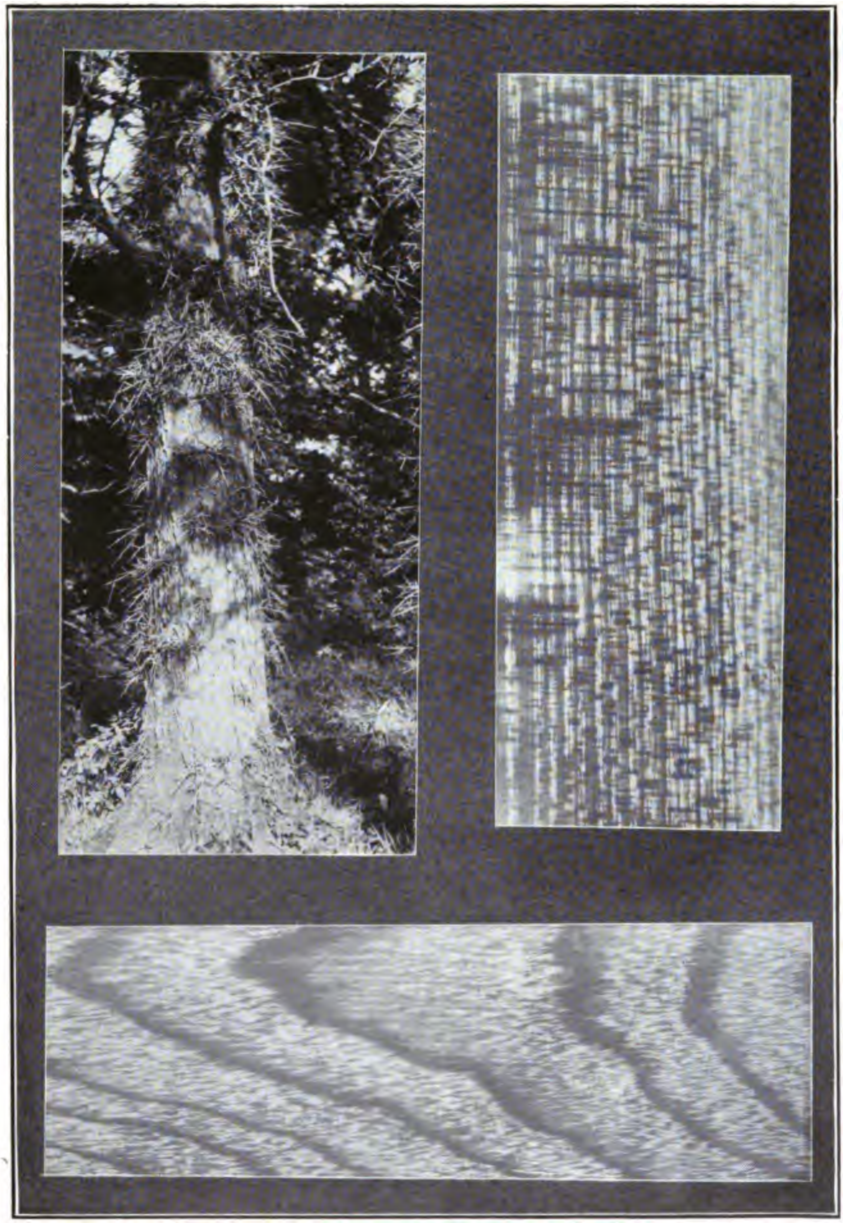
Tangential section.



No. 20. Wild black cherry.

Body of tree. Longitudinal section.

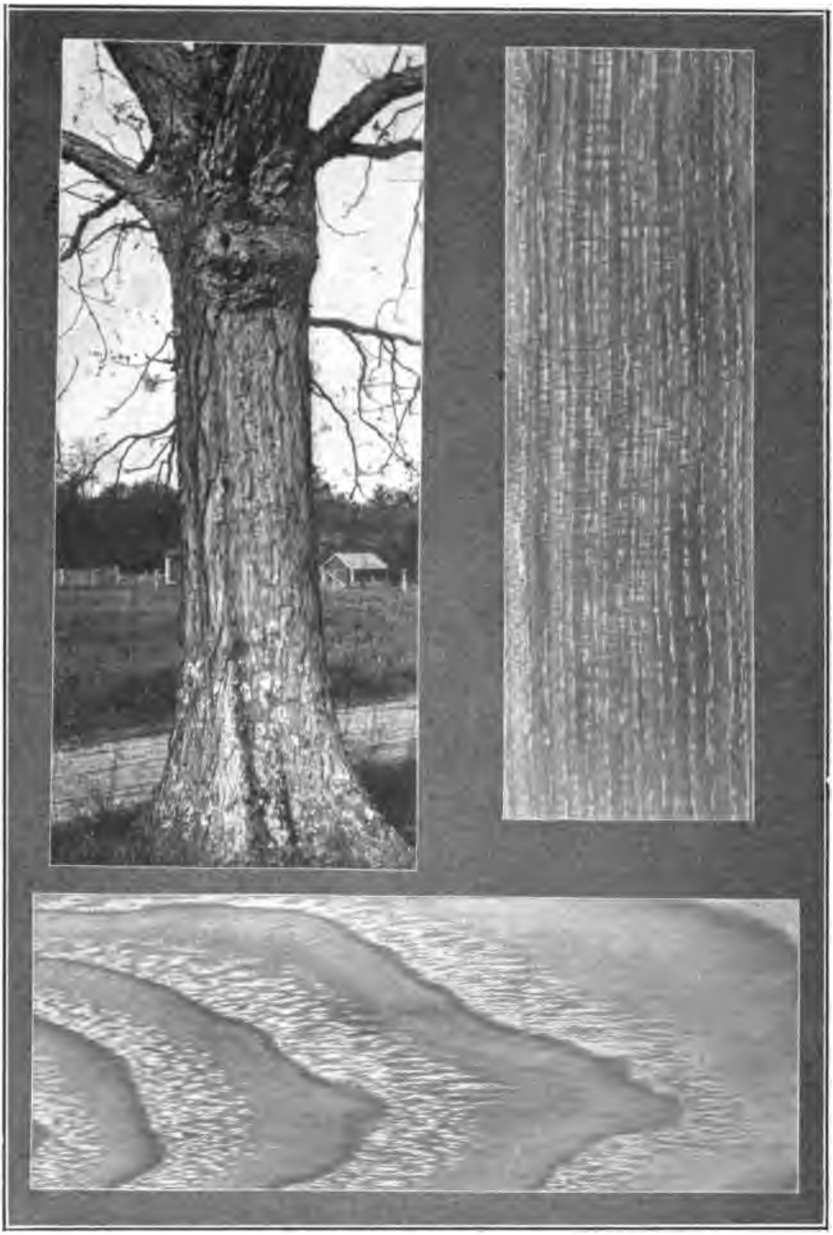
Tangential section.



No. 21. Honey locust.

Body of tree. Longitudinal section.

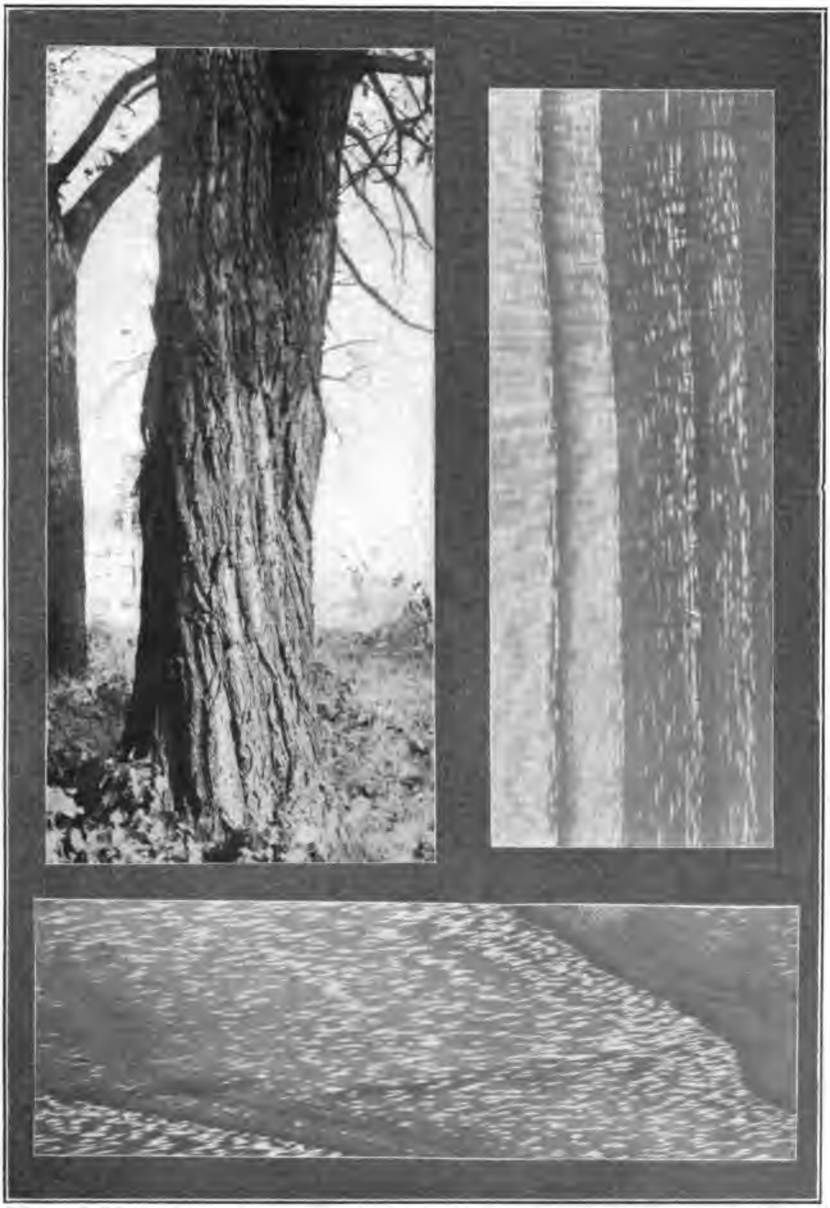
Tangential section.



No. 22. Coffee tree.

Body of tree. Longitudinal section.

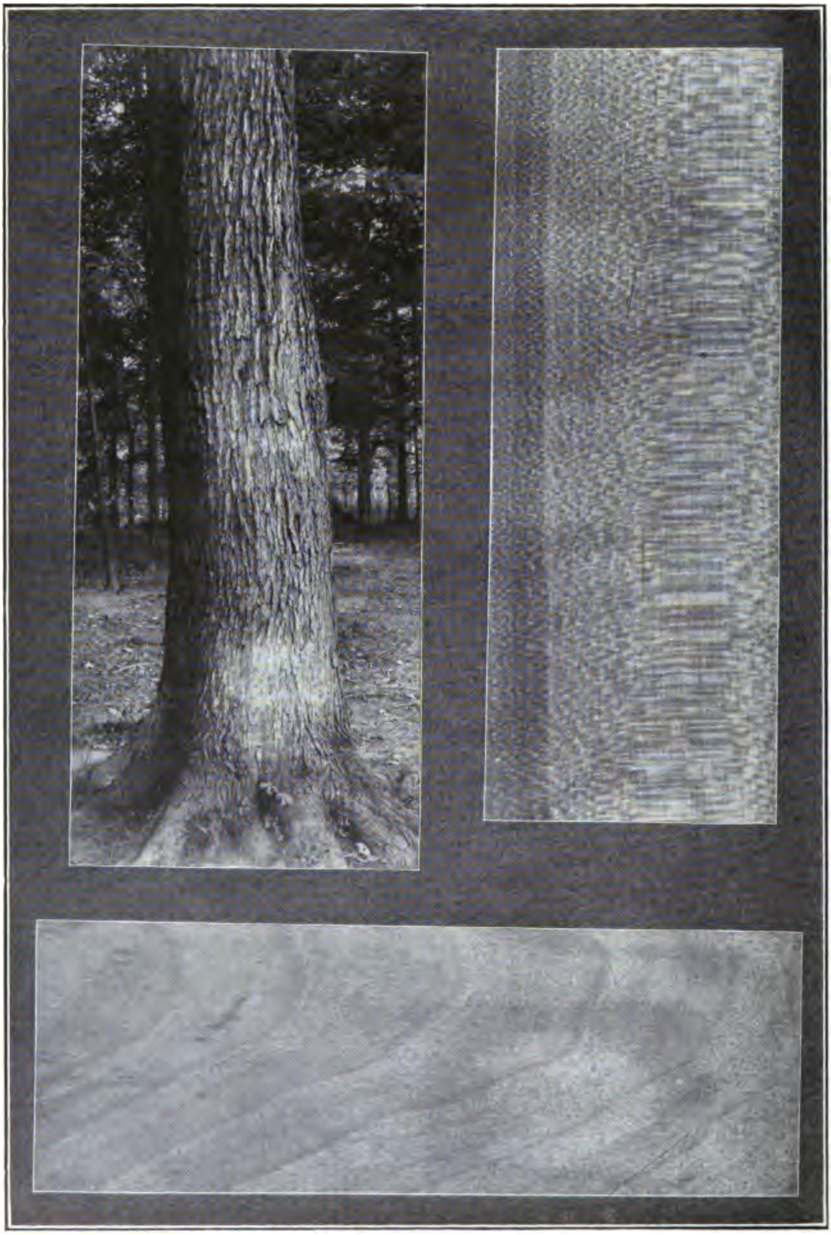
Tangential section.



No. 23. Black locust.

Body of tree. Longitudinal section.

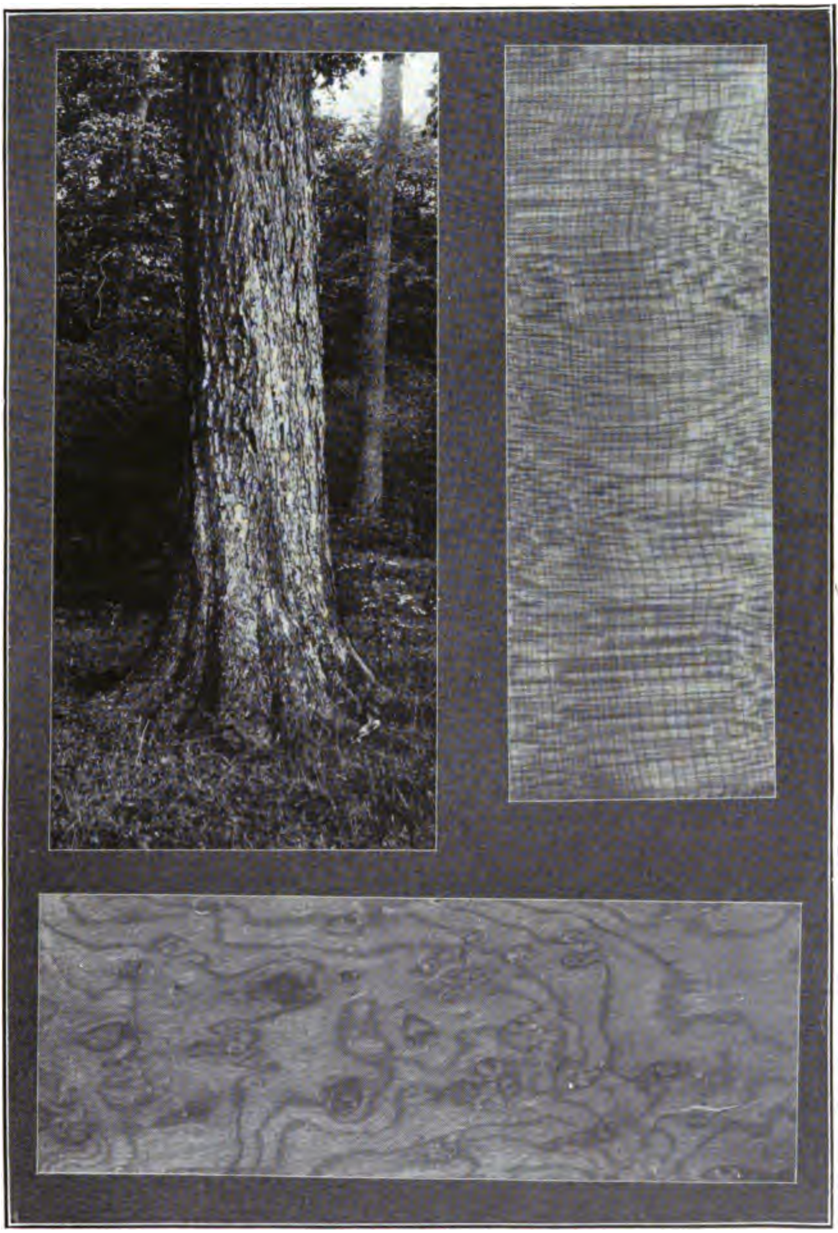
Tangential section.



No. 24. Red maple.

Body of tree. Longitudinal section.

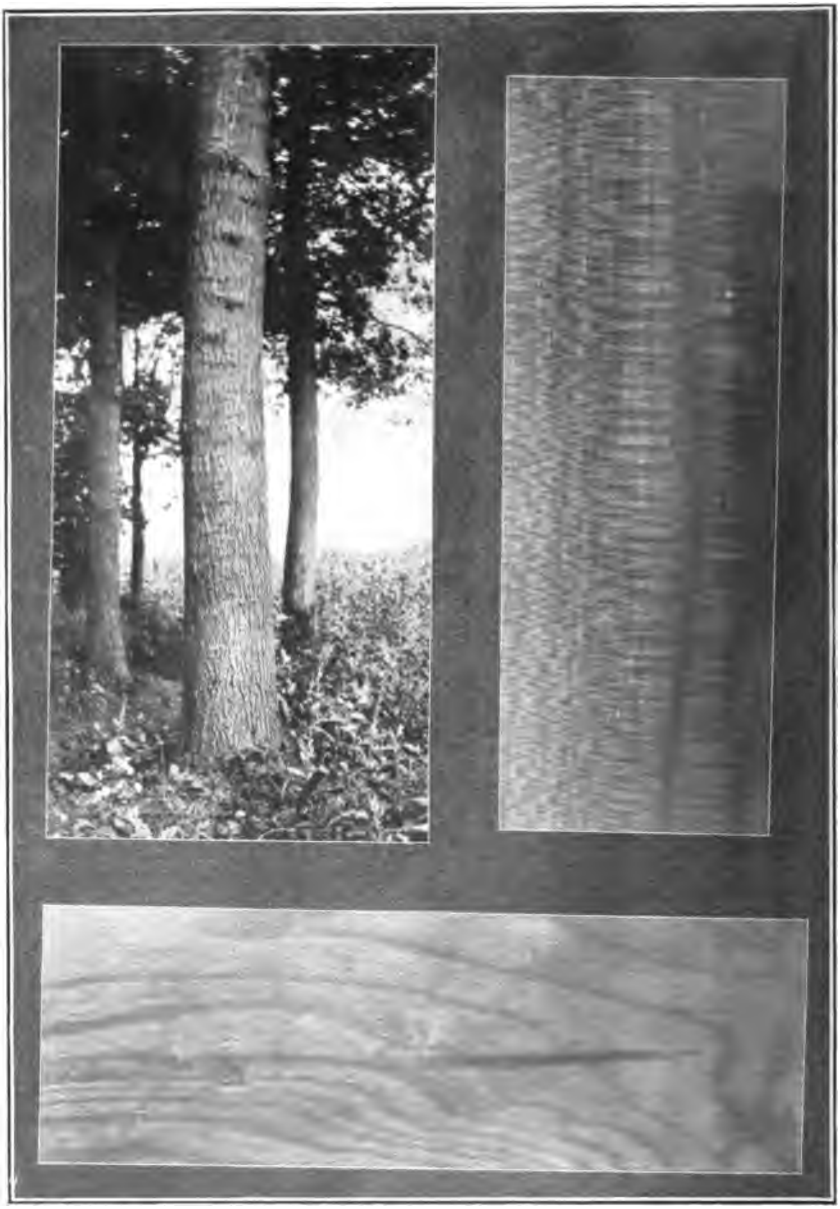
Tangential section.



No. 25. Sugar maple.

Body of tree. Longitudinal section.

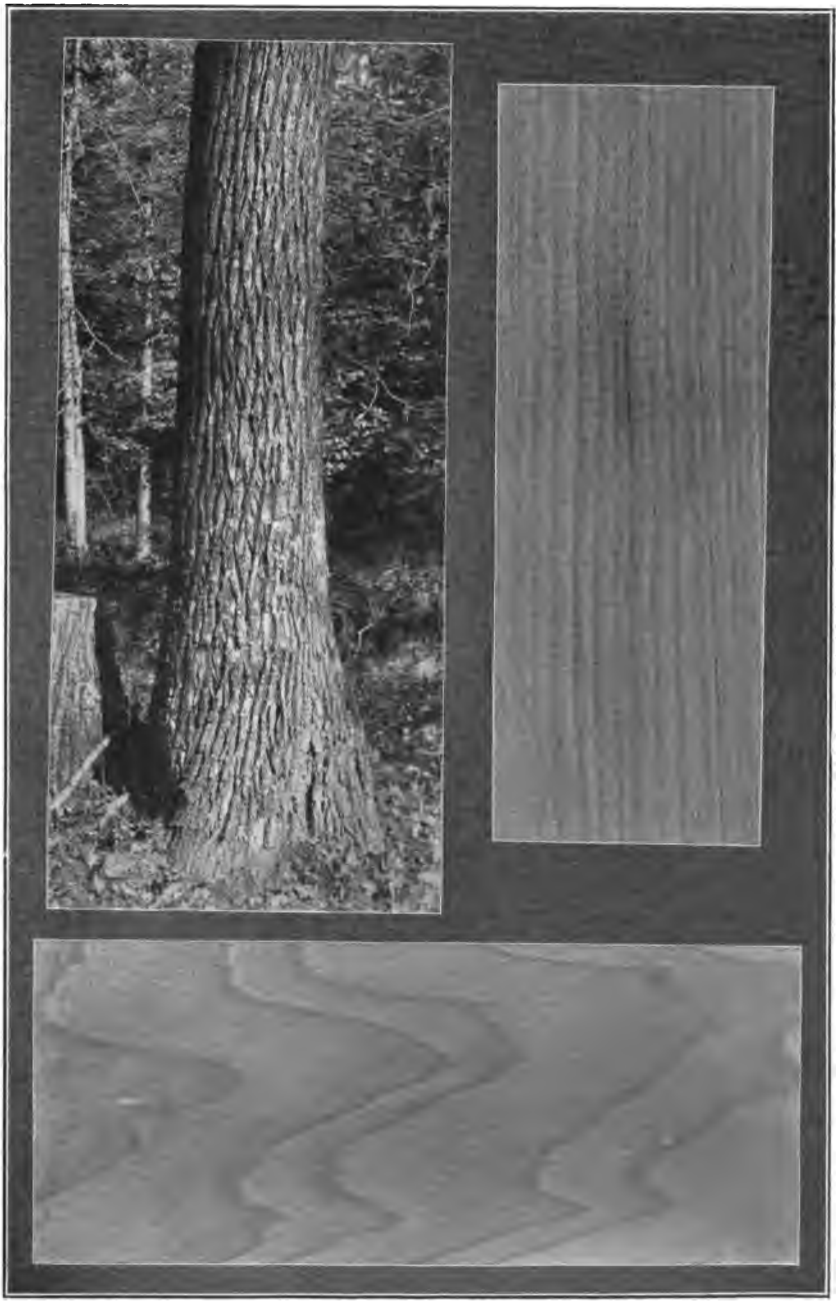
Tangential section.



No. 26. Black sugar maple.

Body of tree. Longitudinal section.

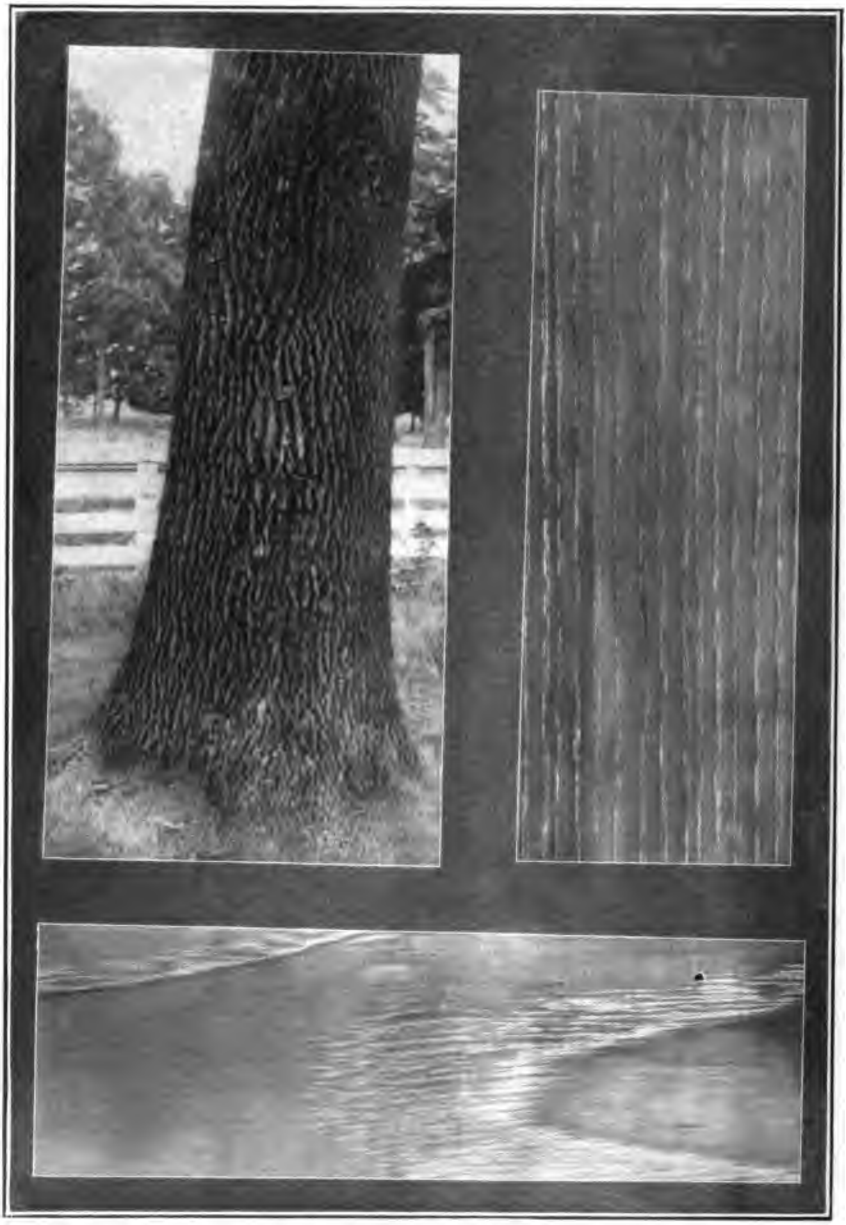
Tangential section.



No. 27. American linden.

Body of tree. Longitudinal section.

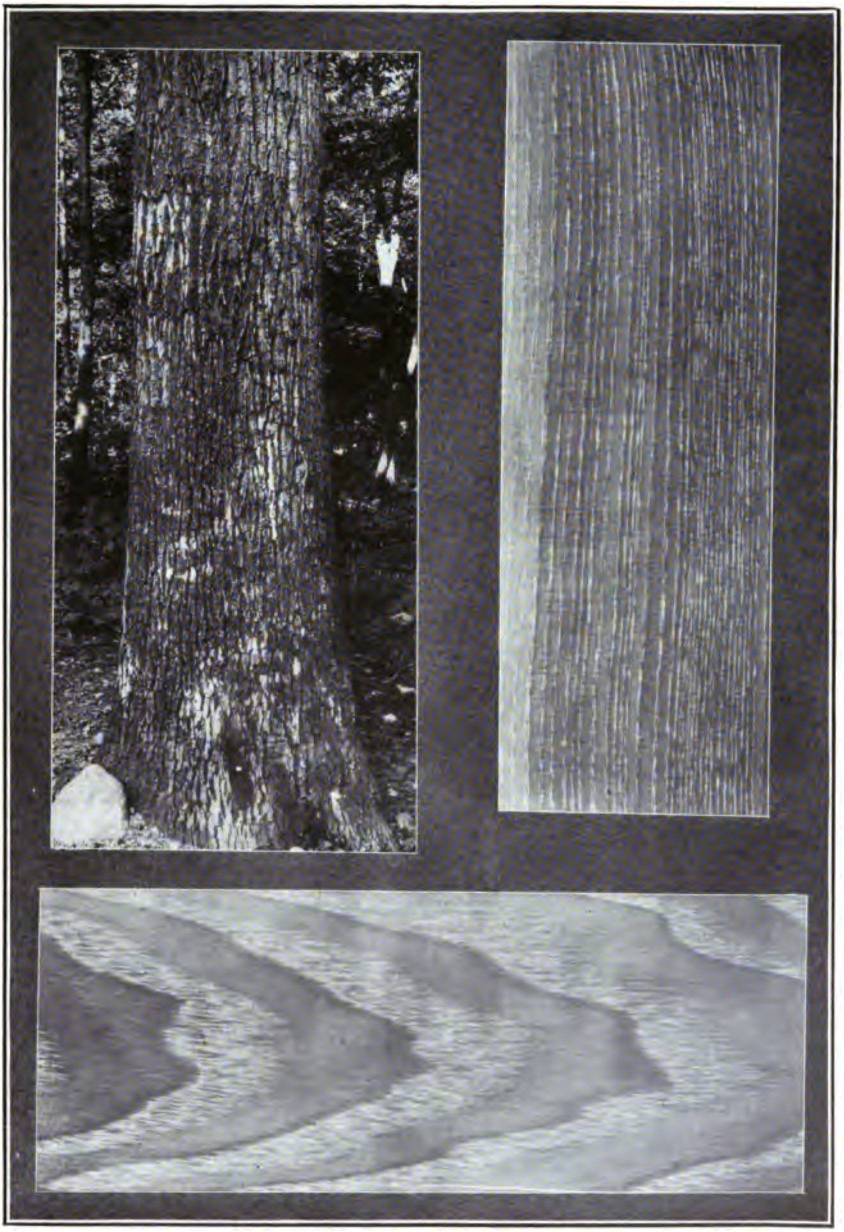
Tangential section.



No. 28. White ash.

Body of tree. Longitudinal section.

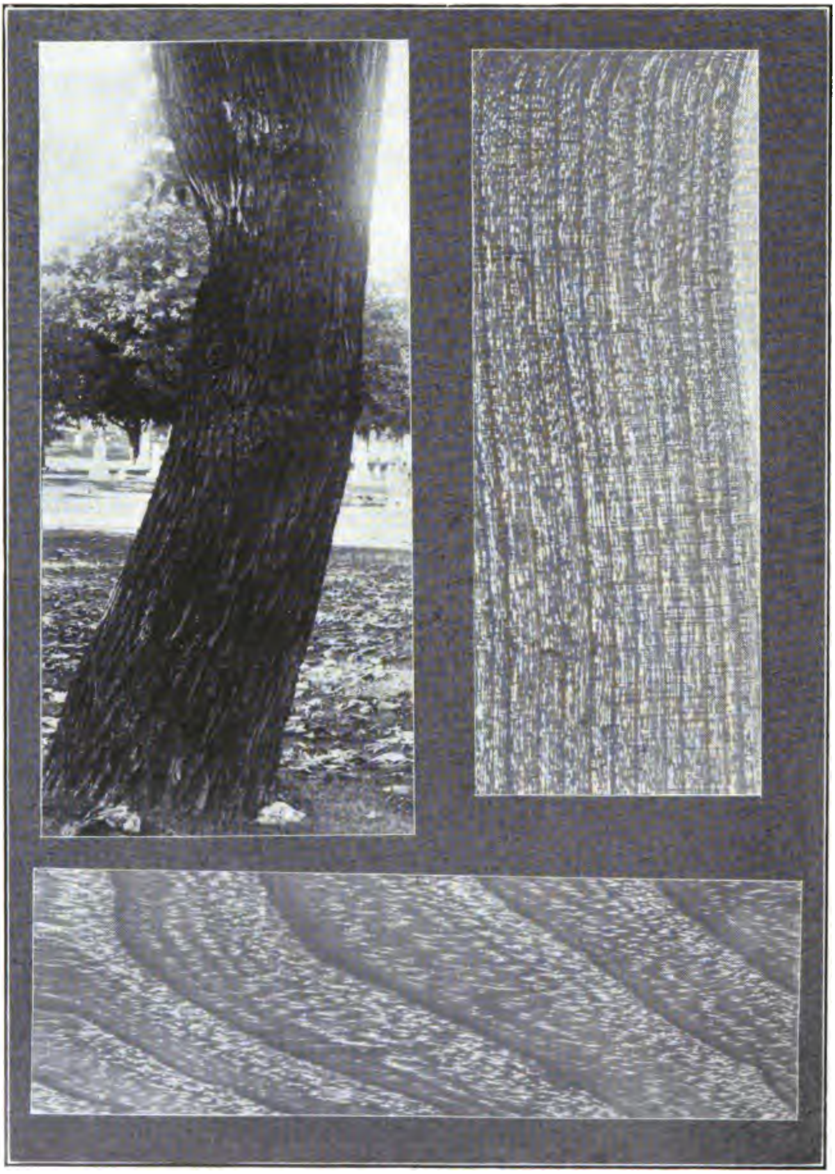
Tangential section.



No. 29. Black ash.

Body of tree. Longitudinal section.

Tangential section.



No. 30. Catalpa.
Body of tree. Longitudinal section.
Tangential section.

The Insect Enemies of Native Forest Trees as Studied Upon the Reserve.

BY GEO. ADE DAVIS AND ARTHUR J. HALTOM,
Special Entomologists for State Board of Forestry.

HENRYVILLE, INDIANA,
STATE RESERVATION,
August 1, 1905.

Indiana State Board of Forestry, Indianapolis, Indiana:

Honorable Sirs—We have the honor to submit herewith, subject to your approval, a report compiled during the months of July and June of the present year upon "The Insect Enemies of Native Forest Trees as Studied Upon the Reserve."

The time spent under salary was four weeks, but outside of this a great amount of work has been done simply to satisfy ourselves, knowing that the allotted period was far too short for the results desired. The members of your board who have spent any study upon kindred subjects will readily agree with us that a full summer might be put upon the work and still leave things undone. We have therefore utilized the time at our disposal in a report concerning the more important damaging forms rather than passing lightly over a multitude of others which presented themselves.

Acting upon the suggestions of your Secretary, Hon. W. H. Freeman, we sacrificed at all times the theoretical for the practical and treated the subjects in a manner calculated to interest the farmer and the lumberman, rather than the scientific student of entomology.

There is ample field upon the Reservation for a series of reports, which should be begun as soon as the vegetation starts its growth in the spring and continued until all plant life has disappeared in the fall. We submit this report for our recommendation.

We wish to give most of the credit for this report to Dr. Stanley Coulter, of Purdue University, whose suggestions and previous instructions guided our work along these lines.

We also wish to express our appreciation of the many favors shown us by Mr. Freeman, and to say that we cannot speak too highly of him and the work he is accomplishing throughout the extent of the Reserve.

If there are statements contained within this report at which you would take issue, we would beg to be corrected.

Thanking you for past courtesy, we are,

Respectfully,
ARTHUR J. HALTOM,
GEO. ADE DAVIS,
Special Entomologists for State Board of Forestry.

When a study of the insect life upon the State Reservation is made, it is presupposed that with very few exceptions the more numerous forms are identical with those found in other portions of the State where forest trees abound. Throughout the extent of the State, north, south, east and west, the general topographical and climatic conditions do not widely vary. Peculiarly situated localities may be subject to peculiar conditions thereby attracting a nominal number of injurious forms, but such conditions will never produce a pest capable in point of numbers of ravaging any large territory. It is, therefore, safe to say that no large forest in the State is now subject to great insect damage not listed within this report.

No attempt has been made to include even a large portion of the innumerable insects living upon the forest trees. It has been our policy rather to put special study upon the most injurious of these which were working great havoc and making war to the death. Of the multitude of species at work upon a tree, it usually happens that a very few indeed are seriously damaging its health, or reducing it to dead wood. Of its many tenants these few may even kill it in a short time without the aid of the myraids of others, many of which may be beneficial.

Although we have omitted many minor forms doing scarcely noticeable damage, we have, however, included those which we should have naturally expected to find and which may be expected at any time. The rise and fall in the number of an order of insects is naturally attended by a balancing fluctuation in the number and variety of its parasites or dependent forms. One year may witness the partial destruction of a certain tree. The next season often sees few or none of the pest which caused the destruction. A period of years may elapse before they again become dominant or are even seen. What may be true of a life form today, may tomorrow be sadly at variance with the facts. Hence, too close watch can not be kept upon the diseased and dying trees from season to season and a timely reporting of a new form often allows ravages to be checked which otherwise would ruin thousands of dollars' worth of timber and jeopardize the lumber prospects of a section. In many cases the remedy suggested is highly practical, in certain places; in others, where conditions are different, utterly worthless. Oftentimes there is no effective remedy. The life of a forest is comparable to the life of a human; environments of

Geo. Ade Davis, entomologist, at work in the forest at the Forest Reservation.

healthful conditions are productive of the best maintenance and growth; a healthy tree, like a healthy body, withstands disease and adverse conditions where an organism in an impaired state of health must perish. Perfect trees are seldom attacked to any large extent by greatly injurious forms, although the leaf eaters do seem to prey upon healthy leaves.

Throughout this report, it has been the aim of the writers, first and last to present the conditions in a purely practical way, reducing as far as possible, the scientific terminology to a language easily understood by the layman. In many cases this has been almost an impossibility, but because of the fact that so great an amount has been written concerning injurious forest insects, which is of little or no value to the farmer or lumberman in his search for readily available information, much interesting matter has been omitted in order to give place to the more practical. Few men well versed in forest timber but recognize the four stages of an insect's life, but they know them by sight only, or by local and sectional names. It may,

Arthur J. Haltom, entomologist, at work inthe forest at the Forest Reservation.

therefore, be well in this connection, to describe briefly these life changes with the technical terms applied.

These stages are called the metamorphoses, and are complete and incomplete. By the incomplete change is meant a growth from the time of hatching to full size, that is, simply an increase in size is made, not a change of the whole body organism. The grasshopper is an example of this growth. A complete change occupies the four stages. The first is the "egg stage," although some eggs are hatched in the body of the mother. Nearly always the eggs are laid on or near the food which gives nourishment to the young. After the egg stage the "larva stage" is reached. Examples are caterpillars, maggots and grubs. In fact, nearly all creatures known as worms are the larvae of insects. The larvae stage is wholly devoted to growth, the sole business of a larva being to eat and grow. All molting (changing of skin) because of increased size is done in the larval stage, later molts being simply for a change of shape. The third change is to the "pupa stage," and is ordinarily a period of inaction save that peculiar and rapid changes go on within the body. Usually they have no power of moving around, but are able to squirm when disturbed. When the last skin of the larva is thrown off, the "pupa" is revealed; they are oblong objects, frequently footless and headless, and sometimes covered with a shiny covering like porcelain. The last stage in the life of an insect is the "adult." This is the mature form. An insect never grows after reaching this stage, so that the idea that large flies are the parents of smaller flies is erroneous. While many adults eat more or less, it is only to sustain life and not for growth. Generally the mature insects live only long enough to lay eggs and perpetuate the species.

Many insect stages take on singular forms and peculiarities, making their identification extremely difficult, but at all times the bureaus of forestry, both State and National, are more than willing to lend such information as is possible.

While the chief amount of investigation has been upon living trees and their insect relations, considerable attention has been given to felled timber with regard to its marketable condition after lying exposed either in the forest or wood-yard.

The young nurseries upon the Reservation (principally walnut, oak, ash, and linn) have been carefully looked over with a view to ascertaining what, if any, insects checked their growth, and the relative amount of damage to lowland and hillside growths has been noted.

In any section, whether or not the topographical conditions be identical with those of another, the flora and fauna will vary to some extent. Much depends upon the thickness or sparseness of settlement, the amount of standing or running water, the acreage of cultivated land, and the rigidity of enforcement of the game laws. These factors have to bear directly upon the balance of animal life, particularly in that locality. It is this balance which determines the supremacy of a form and to it is due also the direct result thereby brought about in the vegetable life of the district. It is, therefore, all important for the man who studies the life habits of insects, in order to better the condition of his timber lands, to bear in mind the animal forms against which he must contend, and the animal forms upon which at least in part must he rely for support. For instance, the woodpecker family seems to be but poorly represented within the Reserve. In three weeks but six red-heads and two flickers (yellow-hammers) were noted. Wherever there is a scarcity of these feathered friends, there will there be under similar conditions a comparative increase in the insect life. In contrast to this, the number of sapsuckers was enormous and their depredations upon the trunks of trees was noticeable everywhere. Snakes, foxes, and carnivorous animals make frightful inroads on ground nesting birds, and lose to the lumberman many of his best insect catchers. This matter is taken up in more extended form elsewhere in this report, but these examples suffice to show the conditions upon which the increase and decrease of an injurious or beneficial form depend.

THE OAKS.

In point of numbers, the oaks exceed by far any other tree on the Reservation. Some ten varieties were found, namely: Pin, post, swamp, white, rock chestnut, shingle, barren, black, scarlet, and red. Of these the white oak is most numerous. Consequently with this tree as a standard we classified the injuries and found that with little if any variation, the whole body of oaks might be classed together with regard to destructive insects.

Upon every hand the ravages of the destructive pests were apparent. Trees ruined by borers, defoliated by leaf eaters, and damaged in wholesale by numerous other insects, stood dying and dead. In the valleys, up the sides of the slopes and on the grassy knobs, were the evidences of a terrible scourge. The destruction can not be overestimated, and to view the remnants of once healthy trees would certainly impress the owner of growing timber with the necessity of fortifying himself against the pest, where his own forests have not already felt the havoc worked.

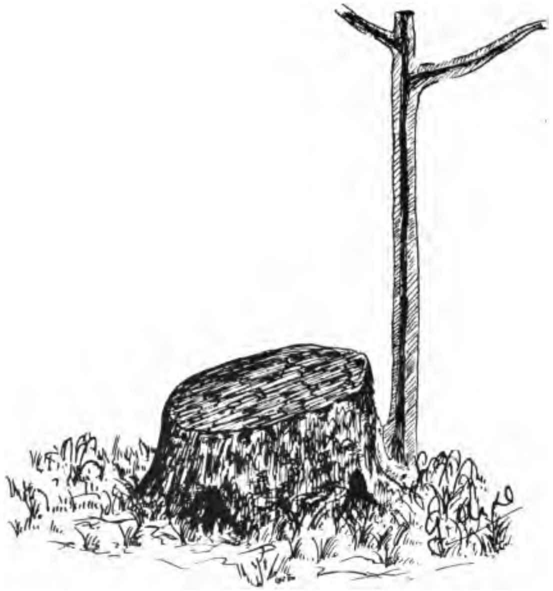


Fig. 1. Old stump with young sprout showing rot. The young growth has been split down to show the discolored wood, but in the drawing the amount of rotten parts have been enlarged in order to be made plain. In the above case the young growth has come out so low upon the stump that it has a chance to send small rootlets into the ground, thereby increasing its chances of health. Where this is impossible, however, the new sprouts show an even greater degree of unsoundness.

The tree injuries may be classed under three heads, viz.: leaf injuries, bark injuries, and trunk injuries, including branch, twig and bud injuries. The roots were found to be in a relatively healthy condition.

At this point the injury of "fire-burn" may be discussed. Prior to the acquisition by the State of the land now included in the

Reserve, a devastating fire burned through almost annually. The young sprouts were killed outright but the older trees were left to rot away, or repair the damage wrought as best they could. At the bases and often to a height of four feet, great charred places almost girdling the tree attracted wood-boring insects from the heavy mulch beneath. Even where the flame itself did not reach the live wood, the heat was so intense that sap-boiling resulted and a yawning cavity almost to the heartwood invited the attacks of the pests. At no point in the surface of the trunk are the conditions more favorable to the entrance of borers than those scars of forest fires, and seldom is a tree able to withstand, not entirely the burn itself, but the ravages which come after. The young and tender shoots are left withered or burned entirely, hence the question of food for the larvae is limited entirely to the older timber.

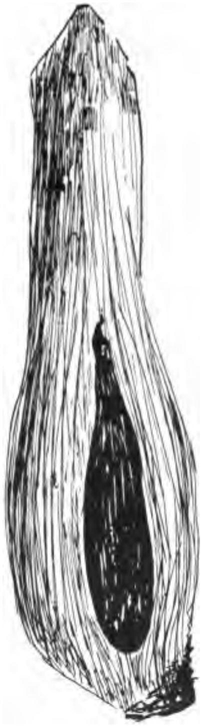


Fig. 2. Abrasion at base of young growth caused by rot from stumps. The rotting of the heartwood makes an unusually attractive place for the entrance of borers. In the above the bark has been removed.

Next to the depredations on burned trees are those upon the growths from old stumps. Of all the stump growths examined, less than 18 per cent. were free from the parent rot and seemingly sturdy enough to produce perfect lumber. As shown in the illustration (Figs. 1 and 2) practically all were slowly rotting for a third of their entire diameter. In many cases the rot extended up the trunk for a distance of twelve feet or more, and the wood was spongy, damp, and discolored. Where several sprouts came

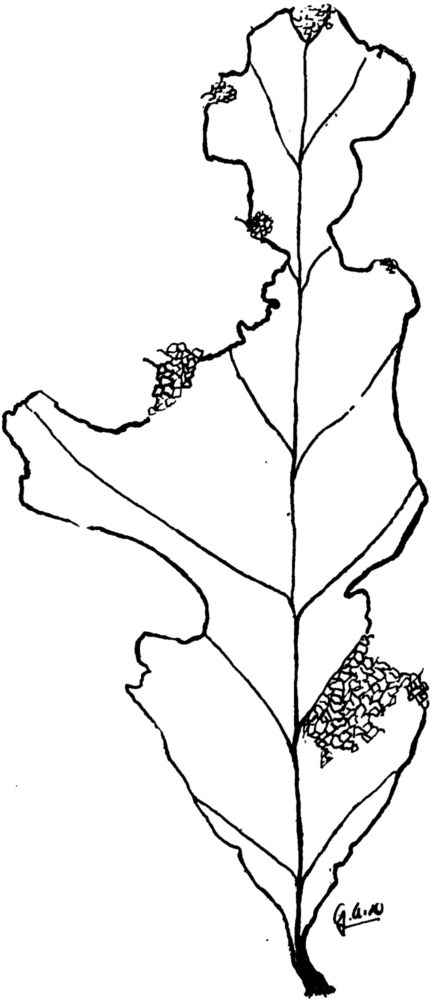
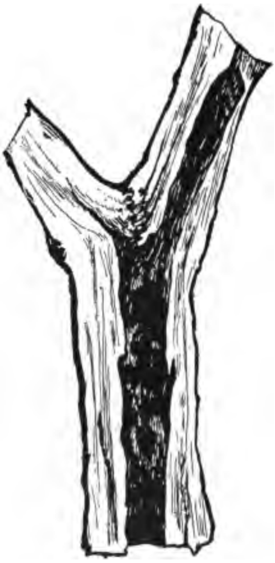
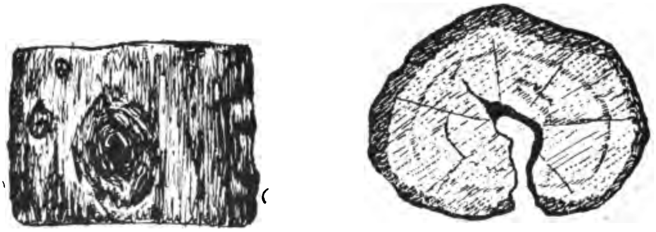


Fig. 3. The result of leaf miners upon the white oak.

Fig. 3. White oak. (Quercus Alba.)

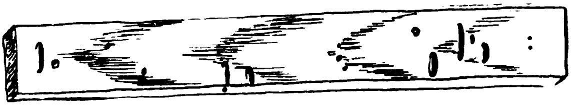


Longitudinal view of the course followed by a borer along the pith in young growth.

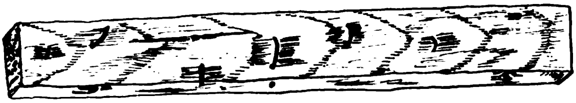


Cross section showing work of borer and section of bark showing entrance of the borer.

Fig. 4.



Timber beetles in hickory.



Timber beetles in oak.

from the same stump the condition was general, and the loss of the heartwood was almost universal where the parent stump showed no signs of being decayed. Thus again were the conditions necessary to insect maintenance made well nigh perfect.

Abrasions of the bark, holes left by sun scalding, depredations of rodents (squirrels and rabbits chiefly), results of scraping caused by felling timber, all leave the tender sapwood open and unprotected from the attacks of destroyers of every kind.

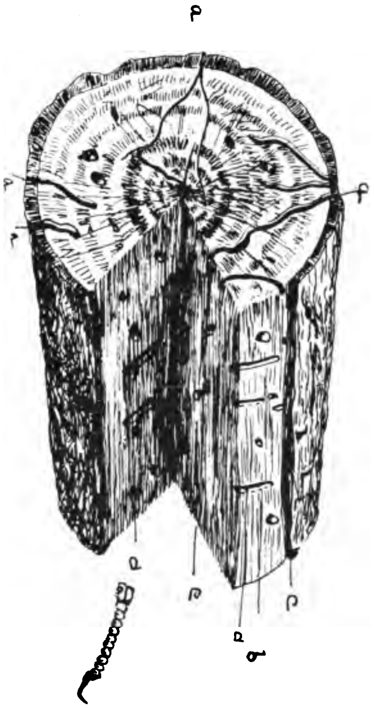


Fig. 5. Work of timber worms in oak.

a. Work of oak timber worm. b. Barked surface. c. Bark. d. Sapwood timber worm and work. c. Sapwood. Oak timber worm. (Eupsalis minuta). Sapwood timber worm (Tlylocaetus lugubris).

A great majority of the borers working upon the oaks entered close to the ground. Indeed, above ten feet we seldom found the outer bark pierced. Single trees standing in the open were as badly infected as those in the heaviest forest, but their proximity to the thick woods easily accounts for this fact. The older oaks

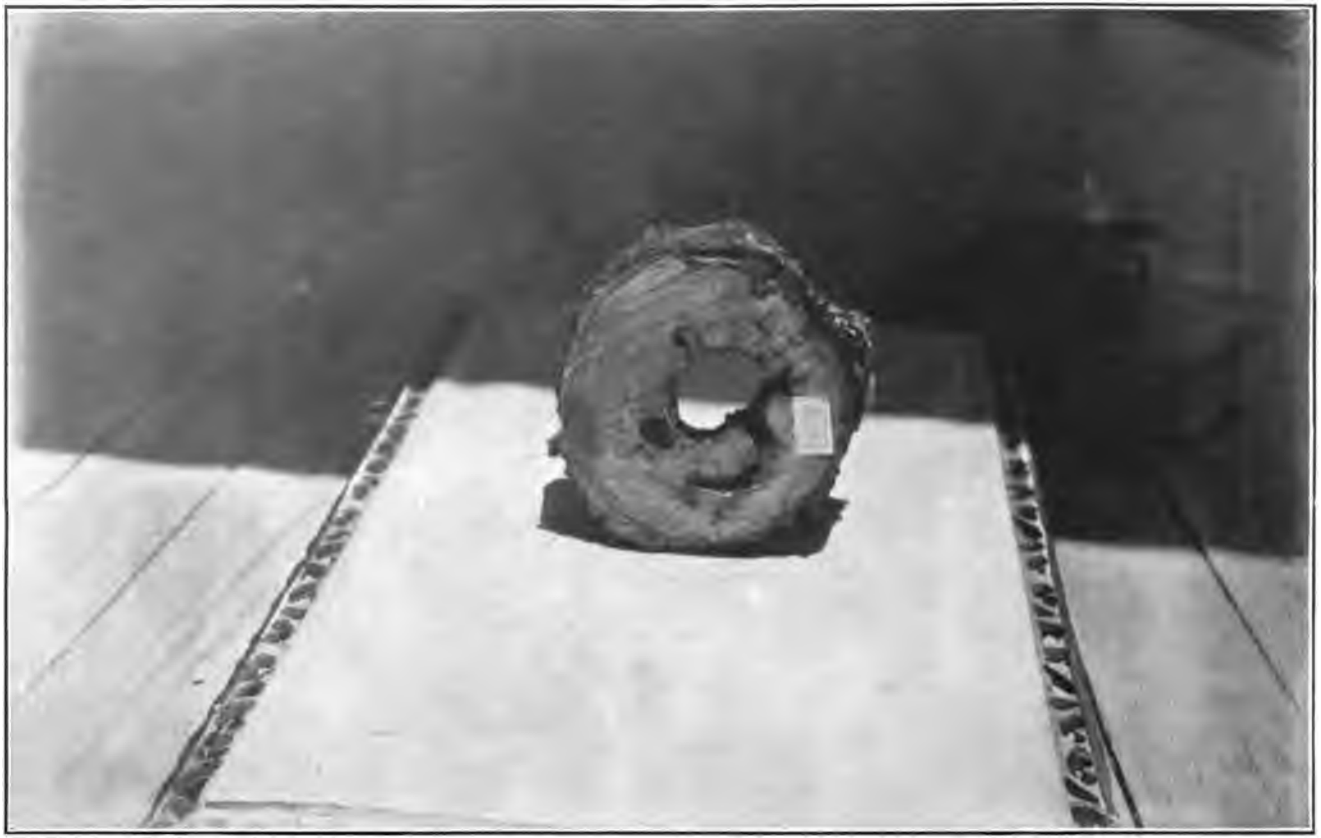


Fig. 6. Cross section of white oak showing work of borers in the heartwood which killed the tree.

which had not been burned or scarred were seldom if ever touched by borers or bark eaters, the greatest damage being done to growths from two to six inches in diameter. (Figs. 3, 4, 5, and 6.)

The leaf injuries comprise one of the greatest sources of danger to the lives of the oaks upon the Reserve. The manner in which the leaves are destroyed is threefold, viz.: rolled, eaten, and mined. The top and sides of the trees were most eaten, while the end twig leaves suffered greatest. (Fig. 7.) The bark injuries were only nominal and led directly to the work within the trunks.

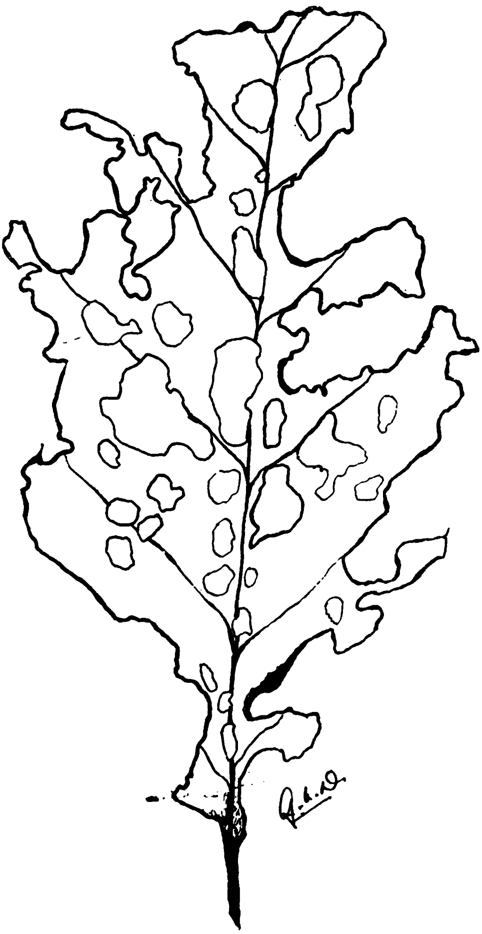


Fig. 7. Black oak leaf totally destroyed in June by leaf-eaters.

In many cases the trunks were nearly honeycombed, while in others the results of the boring insects were as previously described. Very little difference was noted between the amount of work done upon the oaks of the knobs and those growing in the lowlands. Where oaks alone prevailed, however, the damage was greater than where hickory and chestnuts were plentiful. Hillside injuries were more numerous and more effective than those of either the knob tops or valley lands. This may be accounted for by the fact that hillside growths were in a weakened condition due to their struggle to maintain themselves against adverse conditions; lack of sunshine, washing away of mulch, rocky soil, and lack of moisture during comparatively dry seasons. Fungus growths of many varieties appear upon the living trees almost simultaneously with the rotting of a part and work no small injury to the living parts around.

The work of the nut weevils upon the acorns and the results of oak galls, which form the "balls" or "oak-apples," will be taken up together with the other insects of the Reserve.

THE HICKORIES.

On the whole, we found the hickories to be in slightly better condition than the oaks, but the trees affected were more nearly totally destroyed. There seemed to be but little difference between the old hickories of the knobs and valleys. With the younger growths, from two to ten years old, there was much in favor of the knob growth. Like the oaks, the second growth sprouts showed a tendency to rot from the stump, and seemed in all cases more susceptible to the attacks of insects than the seedlings.

Greatest damage was done by borers. Small trees apparently in good health when sawed through were found to be fully two-thirds eaten through by large borers, chief among which was Cyllene pictus. In but few cases was it possible to recognize any of their work whatever from the outside, but a cross section readily revealed the havoc wrought. (Fig. 8.)

Few leaves were found badly eaten, mined or rolled and no root injuries seemed to be affecting either young or old trees. (Fig. 9.) A discussion of the hickory bark beetle is appended.

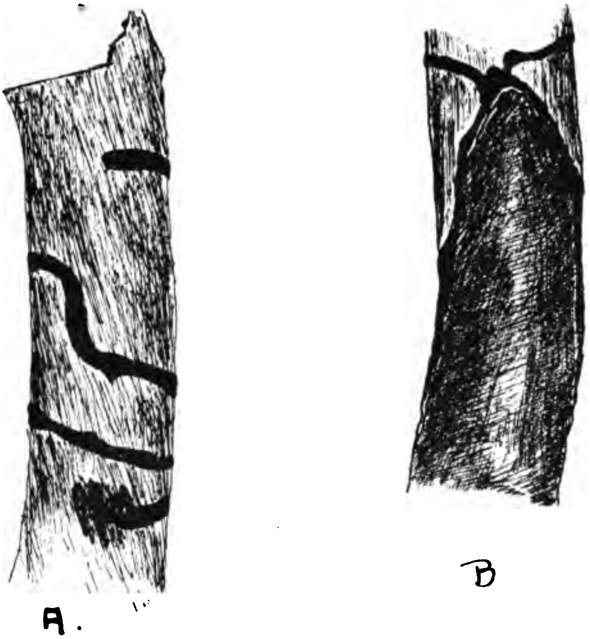


Fig. 8. Young pignut hickory.

a-b. Reverse sides of same stem, showing complete rings just under the bark.

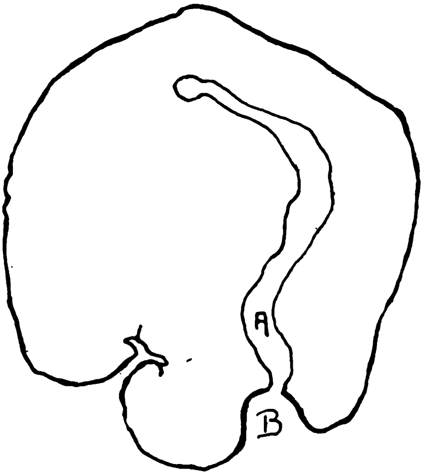


Fig. 8. a. Course of borer in young shell bark hickory after entering through injury at b.

Many varieties of leaf gall were present as were the cuttings in the twigs by cicada. The leaves which were eaten were left like those of the oak, and seemed to have been destroyed in the same manner. First, by eating around the outside; second, by eating all but the midribs and veins; and last, by eating the smaller veins, leaving a shell of the heavier parts. Low sprouts were more seriously damaged than upper parts. Occasionally a dying branch indicated the presence of locusts, and twig girdlers were not uncommon.

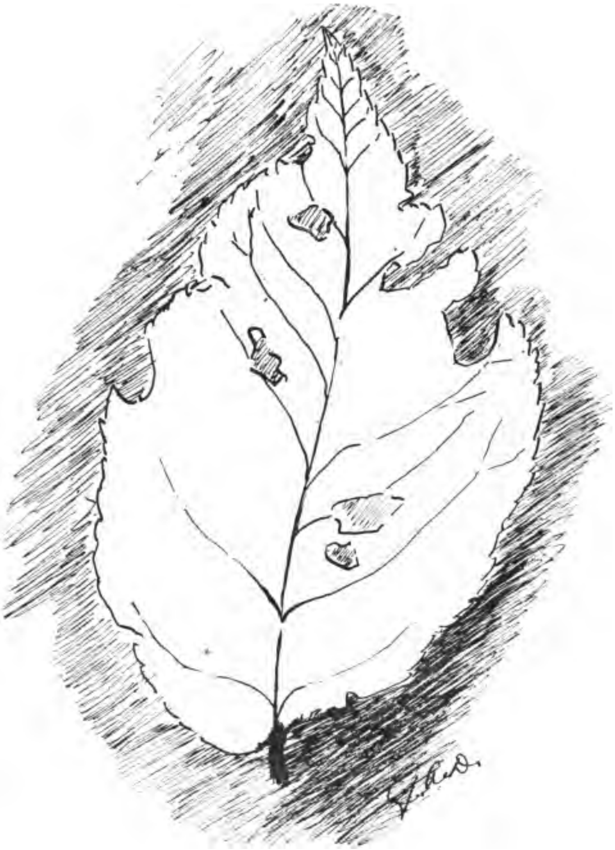


Fig. 9. Shellbark hickory leaf slightly damaged by leaf-eaters.

YELLOW PINE.

No large areas of yellow pine were found upon the reservation. Most of the pine territory had been burned over, leaving but few large trees and an occasional new growth. Between those of the knobs, and those of the lowland there was no difference either in luxuriance of growth or general injury. By exuding the sap or pitch the pine is, in a measure, better equipped to ward off the attacks of bark beetles and borers. There is little chance to stop them before the injury si done. In very few pine trees did we find any injury whatever. In the small number found, they seemed to have lost vitality on account of trimming or exposure before the attack was made. Immediately, however, after the loss of sap from the tree, particularly the yellow pine, there was a rush of rotten or dead wood borers upon it. Trees standing, dead but a short time, were found reduced almost to honeycombs. (Fig. 10.) Logs left lying upon the ground were full of the hungry eaters, and beneath and around them were piles of the chippings fallen from the holes, where they had effected an entrance. By standing near an affected tree or log of this kind, the ceaseless gnawing may be plainly heard, sounding like the rasp of a file. Within a short time, the otherwise serviceable logs are reduced to mere sawdust, and absolutely worthless for lumber. Upon examining a dead pine the mistake may be made that the workers in it at the time of examination were responsible for its death. Such is seldom the case and the insects found within dead wood will rarely attack living timber of any kind, at least in the same life stage. What young pines we were able to examine presented an unimpaired state of health; indeed it was hard to find even a branch dying as the direct result of insect enemies.

LARGE-TOOTHED ASPEN.

Among the healthiest trees found, the large-toothed aspen (Populus grandidentata), commonly called "quaking aspen," must be mentioned. We did not find a single tree, either young or old, which was greatly injured, and with the exception of one young one upon the Knob no leaf eater's work was noted. This single tree was injured barely noticeably and in no wise impaired. The bark showed no signs of bark-eaters, no borers were present, and only some peculiar condition can account for the attack upon this lonely specimen. We were even unable to find where the locusts had deposited eggs in the smaller branches. Very few large aspens were to be found, but wherever located they showed no signs of having been a prey to insect life.

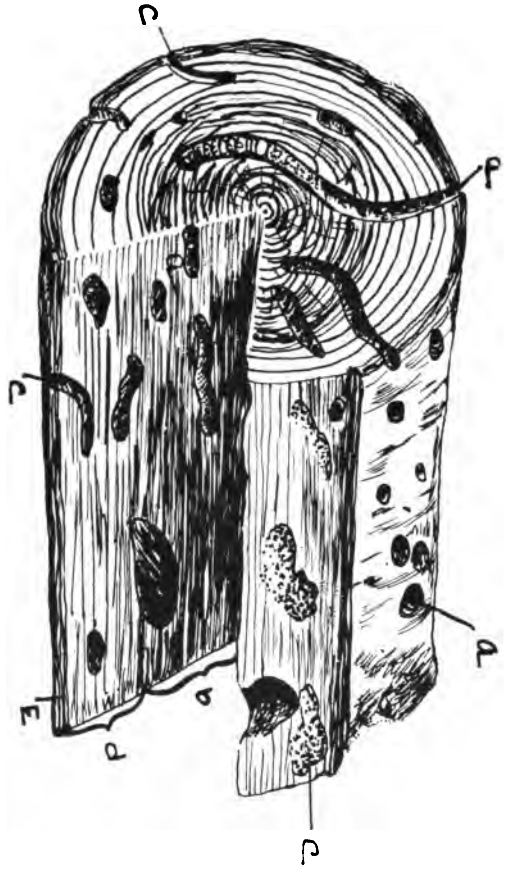


Fig. 10. Work of round and flat-headed borers in pine.

a. Work of round-headed borer. b. Heart wood. c. Work of flat-headed borer. d. Sapwood. e. Bark.

THE RED BIRCH.

The red birch (Betula nigra) was noted along streams near the eastern boundary, and save a few leaves eaten no injuries were apparent.

THE BEECH.

The beeches (Fagus Americana) were, as a rule, healthy. A majority of the larger were partially rotten and hollow at the base as a result of fire-burning and scarring. With this defect were the attendant borers and fungus growths, doing, however, but little damage. The leaves' were slightly rolled in a few cases, with apparently little evil results. The trouble seemed to lie in the depredations committed upon weak trees or recently cut logs, noted in the lumber yard at Henryville, Indiana.

YELLOW POPLAR.

Tulip or yellow poplar (Liriodendron Tulipifera) was one of the best growths found. We cut many young and old growths, carefully noting the bark, leaves, roots, trunks, and branches, and did not find a single insect at work, and but few signs of any previous work.

THE MAPLES.

With the exception of the yellow poplar, the two varieties of maples, red, scarlet or water maple (Acer rubrum), and sugar tree or rock maple (Acer Saccharum), presented the most perfect state of health observed. The absence of the cottony maple scale, of all the borers and many of the leaf-eaters had left them in an unimpaired state of health. Old and young trees wherever found, whether of knob or valley land, flourished with scarce a check to their well ordered advance. Wherever the leaves were eaten there were but few thus treated on single trees and those had been previously galled.

THE WALNUTS.

The walnuts (Juglans nigra) were exceedingly rare upon the Reserve (that is, those of any size), but from those examined we would say that in this section they are subject to no great amount of insect damage. Young walnuts in the nursery with the exception of a very few leaf-eaten were in extremely fine shape. In this connection we may say that after a thorough inspection of all of the nurseries of very young growths we are able to report an utter absence of any forms whatever, which at that time were causing the death of any of the trees. The work of the grasshopper was noticed from time to time but not sufficiently to cause any permanent injury to the parts affected.

THE CHESTNUT.

Few stump growths from old chestnut stumps (Castanea dentata) were found rotting in any way, in this being different from the great majority of sprouting trees. As is well known, when a chestnut tree becomes injured, it immediately sends out young shoots from or near the injured part. It thus overcomes many of the boring insects and maintains itself under extremely unfit conditions. Many leaves were rolled, two or three being bound up together. Other than this we found very few injuries inflicted. The only one worthy of mention was upon the fruit of the tree, the chestnut itself. In order to obtain perfect seed for renewing, the question of healthy chestnuts in the burr is indeed important. The nut-weevils were found in even the very young nuts as well as those already decayed, leaving only soft, brownish acrid pulp where clean live tissue should have been. The subject of nut-weevil is discussed in the appended list of insects.

THE SYCAMORE.

Sycamore along the watercourses were studied first, in the middle of June, and later in July, and at both times mentioned the damage was done principally to the leaves by leaf-eaters and upon the inner bark by engraver beetles. Otherwise both young and old trees isolated and in groves were in excellent condition.

THE GUMS.

Towering above the heavy mass of second growths like true monarchs, the black gums (Myssa sylvatica) reared themselves and seemed to invite with impunity any ravaging pests. The sweet gums (Liquidambar styraciflua) were not less perfect and free from all trunk injuries. It was hard to find even an imperfect branch.

Following is a list of other trees examined, but which in case of any noticeable injury will be sufficiently dealt with in connection with the most general insect forms: Honey locust (Gleditsia triacanthos), linn (Tilia Americana), and white ash (Fraxinus Americana).

INSECTS.

A list of the insects found upon the State Reservation during the month of June, 1905, which were directly concerned in the growth of forest trees in the district:

NUT WEEVIL.

(Bataninus.) Fig. 12.

These beetles are of quite large size, clay yellow in color, and have an exceedingly long and slender black beak or snout. By means of this they puncture the outer coverings of young chestnuts, hickorynuts, walnuts, and acorns, almost to the center of the nut itself. It then places an egg in the hole and pushes it to the central part of the seed by means of the snout. The larva hatches and the small hole in the outside of the nut heals so completely that there is no trace of it in the fully developed fruit. When the nut is ripe and drops to the ground the larva is full grown and eats a hole in the shell when it makes its way into the ground to pupate. It winters in this stage, coming out in the spring when the nut-trees are in full bloom, as a beetle. Considerable injury is sometimes caused in cultivated chestnut groves, but the only practical way to check their advance is to gather the nuts as soon as they fall, either destroy them outright or place them in a tight box—leave until the small worms have emerged and collected at the bottom of the box, when they can be readily destroyed. The nut-weevils were found in large numbers doing great damage to all of the nuts before mentioned.

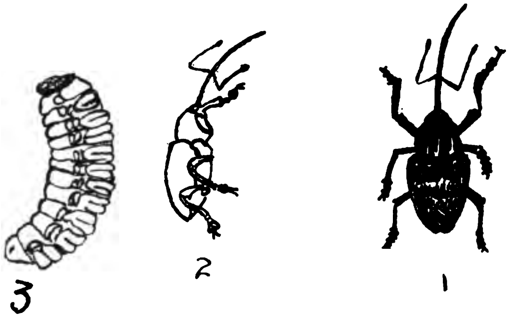


Fig. 12. The nut weevil. Found in the walnut, chestnut, hickory-nut and acorns.
1. From above. 2. Outline from side. 3. Larva.

CICADAS, OR HARVEST FLIES.

These are often miscalled locusts. They are easily identified by their broad, transparent wings, large head, and thin, intensely shrill, loud song, which may be heard during midsummer days. There are many broods, some taking only two years to develop, and some requiring as high as seventeen years. These are the seventeen-year locusts, so called. The latter are especially interesting because of their living sixteen years in the larva stage. They are found principally in the Middle and Northern States. Although the larva feed under ground on the juices of roots, there is no apparent damage except in the way they lay their eggs in the branches. A series of slits are cut in the twigs and smaller branches of the trees, by the female, forming smooth channels in

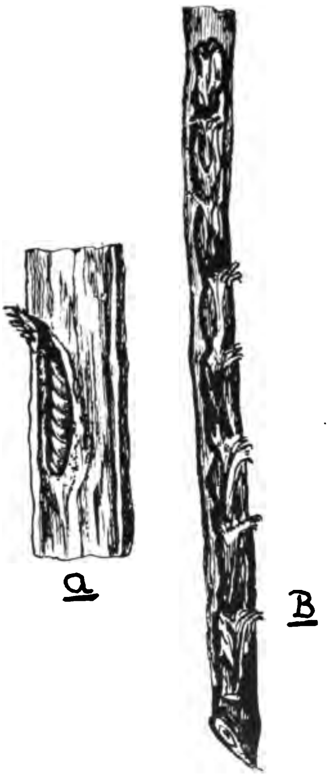
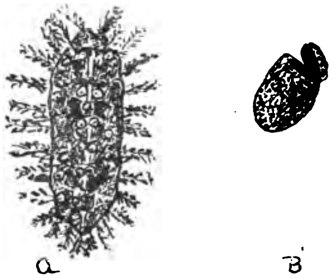


Fig. 13. a. Side view of the egg chamber of the cicada. b. Branch containing old and distended cicada egg punctures.

which she arranges the eggs in series. Fig. 13. These eggs hatch and the larvae crawl down the tree where they enter the ground. There is nothing to be done when such a brood occurs except to take the injury and make the best of it. Valuable trees may be protected by wire netting, but this is only practical in the case of single trees, and out of the question where areas of any size are affected. The nurseryman can protect himself by not putting out young stock when he knows the pest is going to appear. On old trees no damage will be done if no pruning is done the winter preceding the one in which the insect is scheduled to appear, because then they will probably find enough old twigs in which to deposit their eggs. Many young trees are sometimes so injured that they are practically useless because their shape is completely spoiled or their main branches are so weakened that they can not form the proper top. Wherever the English sparrow has been the cicada is doomed. These birds seem to take particular delight in destroying them, and sometimes in certain localities a brood is entirely destroyed in a day by them.

On the Reservation many twigs and branches have been totally ruined, although a large horde has not appeared for several years.

Fig. 14.



a. Slug caterpillar—Larva. (Euclea delphinii.)
b. Cocoon of brown silk.

SPINY OAK SLUG.

(Euclea delphinii.) Fig. 14.

The larva of this insect is one of the most common of our slug caterpillars. The moth is a cinnamon brown color, with a variable number of bright green spots on the fore wings. A large number were found on the Reservation feeding on the oak leaves. The manner of feeding would suggest an arsenic spray, in the case of shade trees, but with the large number of trees in even a small forest this method would be utterly impractical.

OAK PRUNER.

(Elphidion villosum.)

A narrow, brown beetle with rather long stout antennae. The eggs are laid in the small twigs and the larva eats its way into the center of the twig, where it then starts toward the main branch. When full grown it suddenly enlarges its burrow so as to almost sever the twig and then retreats back up the burrow again. The autumn winds break the branch from the tree and the insect remains in it until next spring. A few adults and several indications of their work was found. Wherever they become too numerous, they may be checked by gathering and burning the fallen twigs and branches before the beetle has escaped. They were most numerous upon the oaks of all varieties.

NORTHERN BRENTHID.

(Eupsalis minuta.)

The female has its head prolonged into a slender snout, but in the case of the male the snout is broad and flat, being armed with a pair of powerful jaws. These are weapons of offense, for the males will fight desperately for their mates. This insect was found upon the oak trees in the solid wood where the larvae had bored. A few adults were noted and we also obtained a female depositing her eggs under the bark of the lower branches. They were not numerous enough to cause any alarm, but should they become too plentiful the same remedy used for other borers will take care of them.

FLAT-HEADED BORERS.

(Family Buprestidae.)

These beetles vary much in appearance, but the larvae all resemble each other and are known as "flat-headed borers." Some of the species infect not only trees but shrubs and vines. Some prefer dead or dying wood, some attack healthy wood, and perhaps the majority are indifferent, yet they are more often found in weak than in healthy timber. We were able to find several species in the weakened stump growths of the oak and hickory trees, but we did not consider that they were doing any great damage. We were unable to find any in the vigorous and healthy growths.

YELLOW-NECKED CATERPILLARS.

(Edema albifrons.)

A caterpillar about one and one-fourth inches long with yellow head and body striped with narrow red and black lines. Near the posterior extremity is a rather prominent humped segment of heavy red color. When full grown they go underground to pupate and in the spring come forth as full-grown moths, very gay in color. We found them feeding on Reservation oaks, and in some cases they had almost defoliated healthy trees. Feeding exposed as they do, the best remedy is an arsenite spray wherever practical.

GALL FLIES.

(Family Cymbidae.) Fig. 15.

They resemble a small wasp in form, and are true plant parasites. They produce galls or swellings on parts of the plant, as twigs, leaves, trunk or roots. Among all trees the oak is probably the favorite of this insect. They do not actually eat the plant tissue but cause an irritation which induces an abnormal growth in which the larva lives, changes to the pupa, and finally emerges from the gall leaving it intact except for the hole through which it has come forth. Fig. 16. There are several large spherical balls to be found on almost every oak which have received the common name of "oak apples." These apples may be of different size and appearance, depending upon the species which inflicted the sting. Many small galls will appear upon the same leaf, having just the appearance of small raised spots, which have either a darker or lighter color than the rest of the leaf. All of these galls were found on the Reserve in great quantities, but few, however, were to be found on the small twigs.

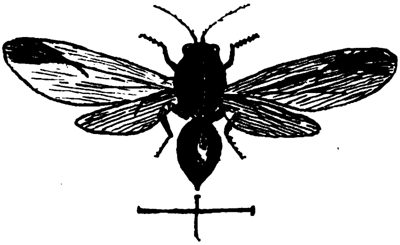


Fig. 15. An oak gall-fly. (Cynipidae.)

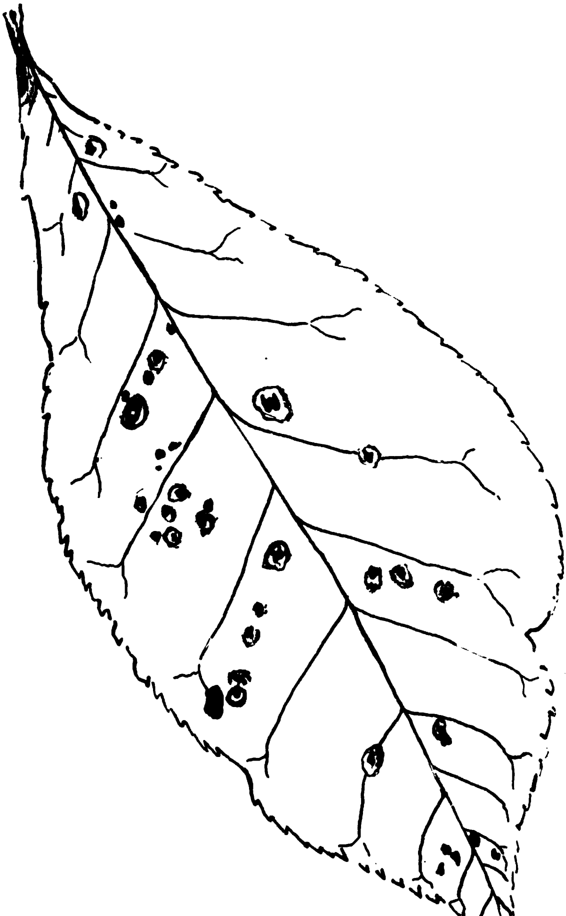


Fig. 16. Gall upon a hickory leaf. Nearly half of all leaves examined were thus marked.

CANKER WORMS.

(Anisopteryx.)

In the larvae stage this is a worm about an inch long with a dark colored back and sides, and yellow beneath. It varies much in its markings. The eggs are laid in the spring and the larvae hatch and are matured in about three weeks. They let themselves down on a slender thread or climb down the trunk of the tree and go into the ground to pupate. The fact that the female is wingless and must climb the tree in order to lay her eggs suggests the effectiveness of putting bands of cotton, etc., around the trunks. She will thus be forced to lay her eggs below the band and when the larvae hatch they will have nothing to feed upon. Single trees may be sprayed in the spring with Paris green.

Oak and elm leaves evidenced the presence of the canker worm some time during the spring, and much damage was done in all parts of the Reservation.

PAINTED HICKORY BORER.

(Cyllene pictus.)

The adult beetle is light-brown striped and about three-fourths of an inch in length. The borer is white with anterior segments enlarged. The mouth parts are well developed in both the larva and the adult stages. The adult appears in the spring and the larva bores into the hickory and makes irregular channels about one-fourth inch in diameter, in all directions. This is one of the worst pests to the young hickory we found. Probably 15 per cent. of the hickories we examined, from two to six inches in diameter, were ruined for lumber purposes by this insect. The remedy for all borers includes this hardy pest.

In the photograph which was taken on the Forest Reservation, just after the young hickory was cut, may be seen the extent to which the Cyllene pictus will eat the live wood. The section was split into halves and even after being brought to the light, the insect kept at its work of destruction. Two of these were found in the block shown; one may be seen pinned near the top of the right-hand section. Also the large hole where an entrance was effected is shown and the brown dusty excrement which fills the deep channels after the borer has passed through. (Fig. 17.)

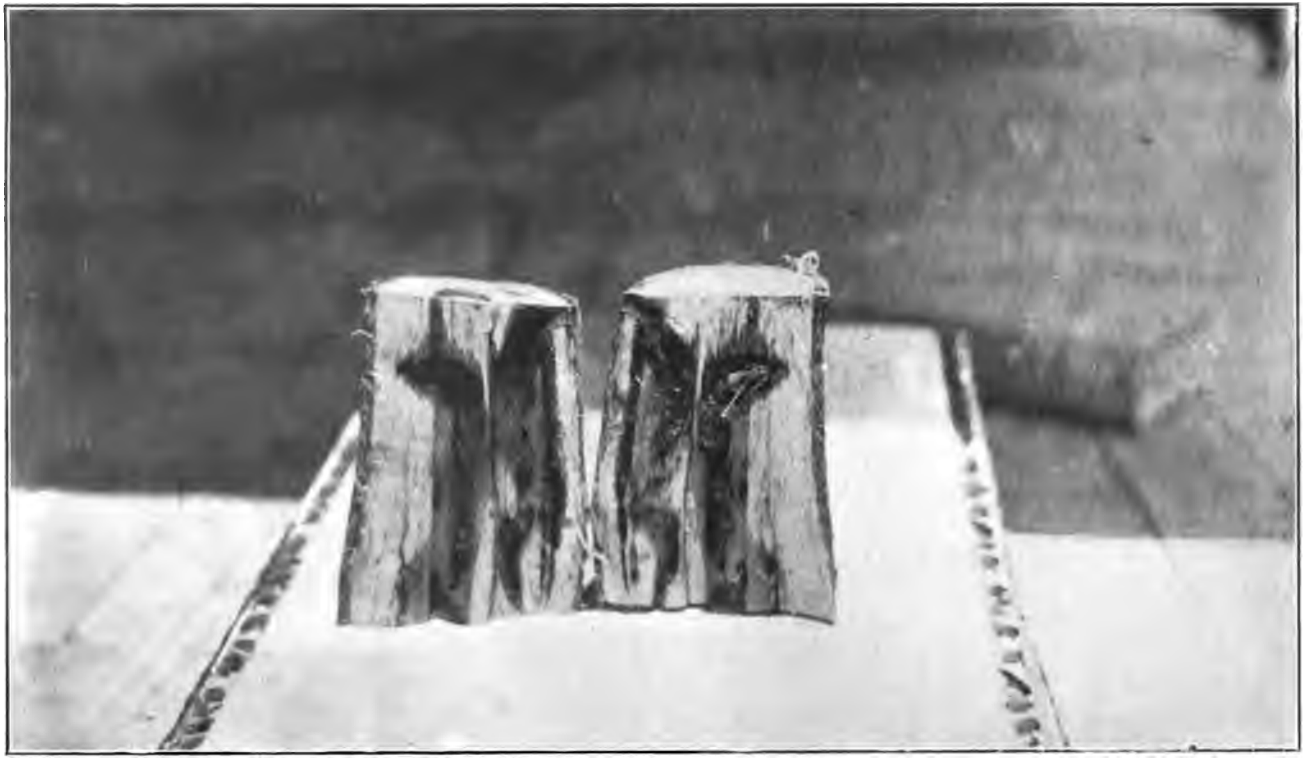


Fig. 17. Section of hickory showing work of Cyllene Pictus. Near the top of the right-hand section may be seen the pictus lying in the channel in which it had worked. At the bottom of the same section the anterior portion of another may also be observed. From the outside of the tree no signs of their work were visible. The channels are about one-half inch deep, and filled with a brown, dusty excrement of the beetle.

THE HEARTWOOD PINE BORER.

(Chalcophors virginiensis.)

A large copper-colored beetle with the upper surface roughened by irregular furrows. The larva is a white, footless grub with the anterior segment greatly enlarged. The adult appears late in the spring in the vicinity of pine trees. The damage done by the larvae consists in the boring into the heartwood of the tree. They generally prefer dead timber, but it has been reported that they will attack living wood as well. Hundreds of dead pine left standing were infested, scarcely a tree but had its colony, and pine logs which had been cut in the spring were full of the insects. Their chipping was easily heard at a distance of fifteen feet from the log, and in many places they had so eaten the timber that nothing but piles of sawdust were left. In no case were we able to find them working in or even on living trees.

PINE BARK BEETLE.

(Hyrlungus tenebrans.)

A rather large red beetle, very abundant in the spring. The larva is a white, footless grub with the anterior segment enlarged. It works under the bark of pine trees, mining the inner bark into channels, and slightly eating the sapwood. (Fig. 18.) They rarely attack healthy trees. They were doing great damage to the dead wood, cut logs and felled timber in all parts of the forest.

When the tree is cut, or a short time afterwards, the bark should be stripped off and the insect will do but very little damage.

SAP BEETLES.

This includes several families of small beetles found living on the sap in trees and are generally found just under the bark or around a wound in the tree. They live wholly upon the sap and are neither markedly beneficial or injurious. We found several different species almost every day on and under the bark of the oak, hickory and pine.

ENGRAVER BEETLES, BARK BEETLES.

(Family Scolytidae.) Fig. 19.

There are many species in this family and we will not attempt to deal with them separately, but as a whole. If the bark be torn off from a dead branch or trunk, in many cases the sapwood will be found to be burrowed in all directions in a more or less regular form. (Fig. 20.) The beetles that accomplish this peculiar work

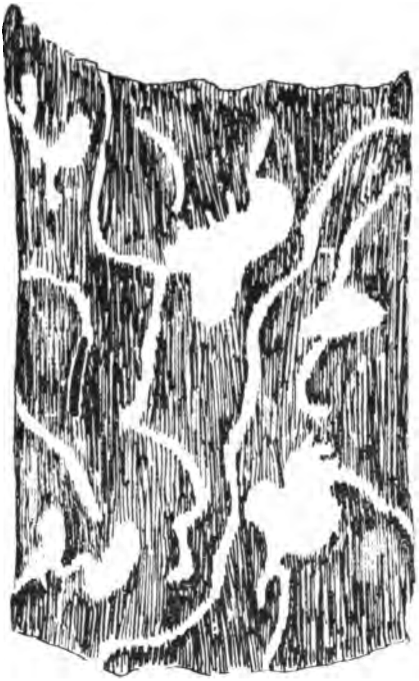


Fig. 18. Work of an engraver beetle upon white pine. The channels are cut just beneath the outer bark. In the above drawing the bark has been removed down to the tender wood.

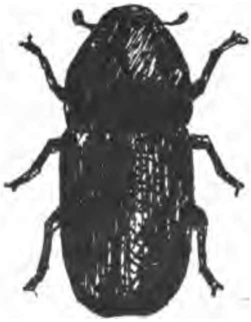


Fig. 19. Scalytids-engraver beetle. Found making complete rings under the outer bark of the white pine.

are mostly cylindrical in form and of small size, many of them being microscopic. They are usually dark in color, many of the species work just under the bark, and still others bore down into the solid wood. The members of this family are among the most dangerous of the insect enemies of forest trees. In many cases trees are killed outright, but in others although the life of the tree is not taken the wood is much injured by the burrows. In some cases we decided that some ash and pine trees had been killed by these beetles, but we found by far the greater number on dead or dying wood.

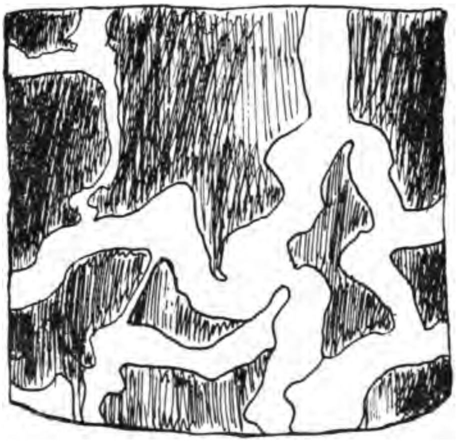


Fig. 20. The bark has been removed to show the irregular channels made by the engraver beetle. These channels are about ⅛ inch deep and are cut down into the living wood, just beneath the bark, resulting in the death of the tree. (Persimmon.)

PLANT LICE.

(Family Aphididae.)

Plant lice were very abundant on the Reserve, being found on many varieties of trees, but probably to a larger extent on young poplars.

Plant lice are well know insects; they infest all kinds of vegetation in all parts of the country. There are a large number of species, and these vary much in life history and habits. Most of them are hatched from the egg in the spring and all the descendents reproduce young. This is kept up until when they wish to lay eggs to keep over the winter, and then both males and females are produced. Any of these species may be wingless or winged. They are very susceptible to cold damp weather and many of them are destroyed during changes of this kind, but on the other hand, a warm moist temperature favors their development and reproduction goes on at a rapid rate.

These insects are known to feed on almost any kind of vegetation and will feed on any part of the plant, as the trunk, leaves, branches or roots. Certain species generally feed upon certain plants. Many are the causes of galls on leaves, especially of the hickory and elm. Ants care for them and feed them in order to obtain the honey-like juice which they secrete upon their abdomens, hence the name "ant cows."

They feed by puncturing the plant and sucking the juices from it so that to exterminate them a contact poison is necessary.

ANTS.

(Family Formicina.)

Ants are so very common that we will spend but very little time upon them. Four kinds were observed; the large black, the medium sized brown, the small red, and the white ants. It is generally supposed that they really eat the plant lice but this is not true as they are only keeping them for the sweet juices secreted. They are only mentioned here because of this habit of keeping the plant lice. The ants themselves are not injurious but the lice have been found to do considerable damage to the young trees. As a general rule, the presence of ants simply indicate the presence of the plant lice. The ants may be destroyed by pouring carbon bisulphide into the holes or nests. We found the white ants in decaying stumps and in the trunks of dying sycamores.

CLICK BEETLES.

(Family Elateridae.)

The species of this family vary much in size but all have the same habit of jumping into the air when placed upon their backs.

The larvae of this beetle are known to the farmer as the "wire worms." Many species were found boring through the decaying parts of oak trees into the wood.

STAG BEETLES.

(Lucanus Dama.)

This beetle, commonly known as pinching bug, was found in large numbers in the larvae stage and was found feeding in decaying woods and old stumps. It never destroys living vegetation. It may, therefore, be classed as beneficial rather than injurious.

LONG-HORNED BEETLES.

(Family cerambycidae.)

These beetles are large, being from one to two inches in length. The larva of the species found is a large fleshy grub, and is supposed to feed on the roots of the poplar tree, although we were unable to find any evidence of them. Several adults were found in widely separated places.

PLANT SCALE.

(Family Coccidae.)

The absence of scale insect on the Reservation was very surprising. All of the principal forest trees were carefully examined, as were also some of the fruit trees and we were able to find but one species. This we found upon a single poplar tree, and in this instance it was only infesting a few branches. It was not common enough to do any damage. The specimens were about the size of the scurfy, with the exception that they were entirely oval in form. We were unable to identify them.

LADY BUG.

(Family Coccinellidae.)

These are small oval beetles bearing either black bodies with red dots or red bodies with black dots. The larvae feed upon plant lice and scale insects, as do the adults. The larvae also have small heads and long legs and have spiny projections like warts extending from their bodies.

There are many species, but almost all are predaceous and feed as before mentioned. They are one of the best friends in the insect family to the forester and nurseryman, and should be protected wherever found. There are a large number within the State forest, but a much greater number would have greatly reduced the injuries to the many damaged trees.

LEAF-HOPPERS.

(Family Jassidae.)

Small, slender bugs which are found upon all kinds of vegetation. A few species were found feeding upon shrubs and trees but no material damage was inflicted. They may be destroyed by a strong solution of soap or with kerosene emulsion.

TREE HOPPERS.

(Family Membracidae.)

These are very peculiar sharp-edged looking insects. They resemble the beech nut and are very grotesque. Seldom appear in sufficient numbers to do much damage. Many different species were inhabiting shrubs and trees but comparatively so few that no notice need be taken of their work.

ICHNEUMON FLIES.

(Family Ichneumonidae.) Fig. 21.

This family contains the great majority of all parasitic insects. Many other insects take an important part in the destruction of insect pests, but they are generally only predaceous and destroy only

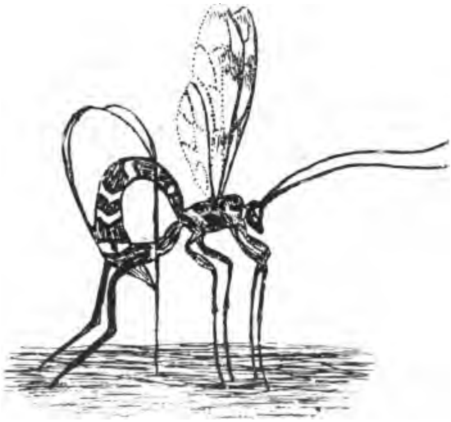


Fig. 21. An Ichneumon fly (Thalessa lunator).

When the female finds a tree infested by the larvae of the pigeon horntail, she selects a place which she judges is opposite a burrow. Then she elevates her long ovipositor over her back, with its tip on the bark of the tree, and with her body for a derrick, drills a hole with great skill and precision. When the burrow is reached she deposits an egg in it. The larvae hatched from it goes along the burrow until it finds its victim, then fastens itself to it and destroys it by sucking the blood.

those upon which they can pounce and overcome. The true parasite does not act in this way. The eggs are laid either within or upon the insect to be destroyed. When they have hatched the larvae live with the host until the pupal stage is reached. Then generally the white pupal cases may be found attached to the host's body. They then go into the adult stage and lay their eggs as did the parent upon other insects. The importance of this family can not be overestimated as some of our most injurious pests have been entirely destroyed by a single variety of parasite. Most of the caterpillars on the Reservation were infested with some member of this family and seemed slowly succumbing to the drain upon its vitality.

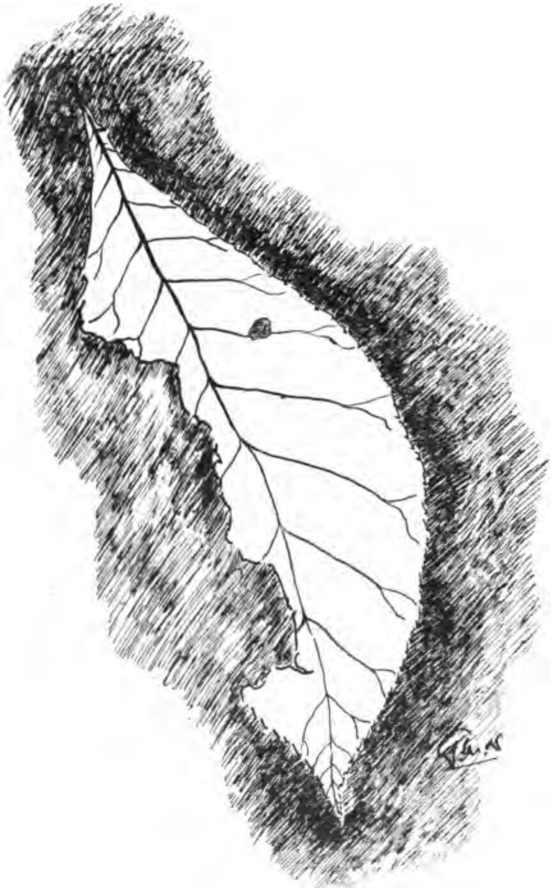


Fig. 22. A majority of the leaves of the pig-nut hickory (Hicoria globra) are eaten in this way.

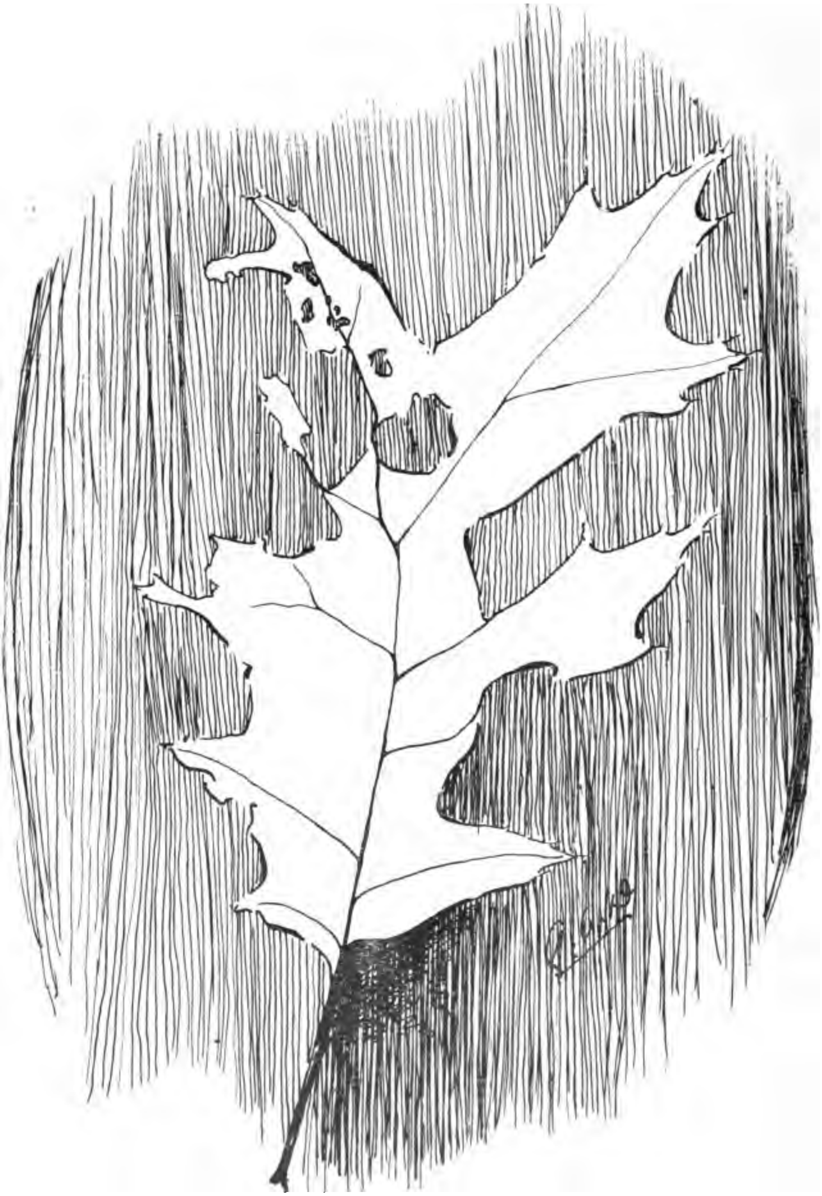


Fig. 23. Scarlet oak leaf destruction by leaf-eaters.

LEAF BEETLES.

(Family Chrysomelidae.)

These beetles are oval or oblong often very thick, with short antennae and round prominent eyes. To this family belong some very dangerous pests. The larvae are short, round, cylindrical or flattened, sometimes gayly colored, and are generally termed slugs. They feed upon leaves in both the larvae and adult stages.

The adults we were unable to identify, but hundreds of forest trees had been ruined by their depredations. Figs. 22, 23, 24, 25, and 26.

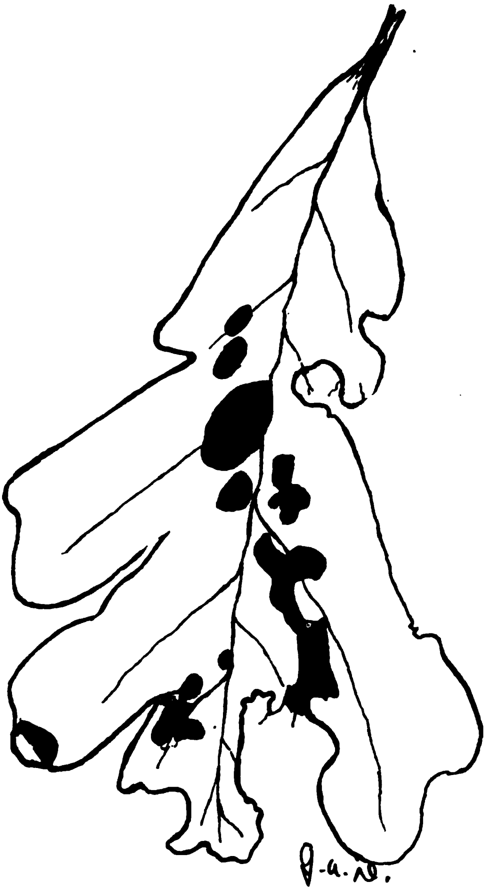


Fig. 24. Destruction of white oak leaf by leaf-eater.

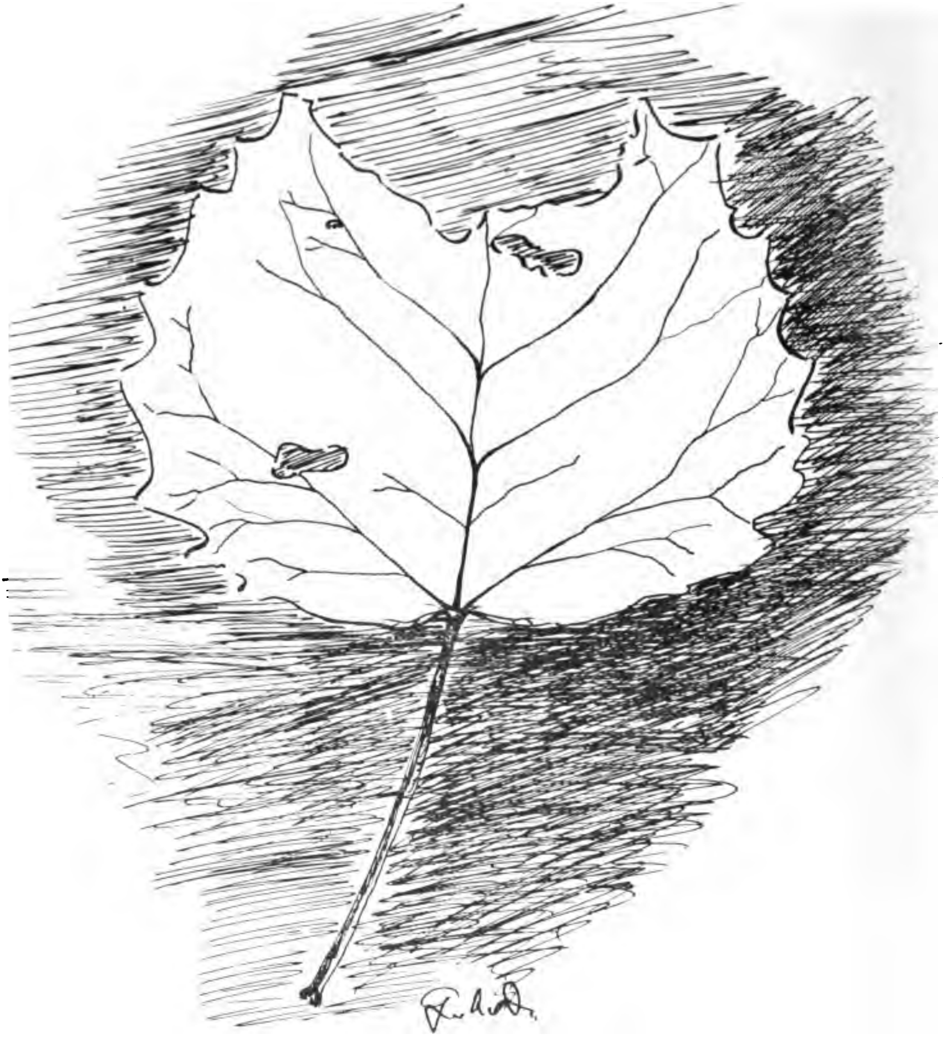


Fig. 25. Very little damage has been done to the leaves of the large toothed aspen (Popluus gradidentata). The above cut shows the only injury worked by leaf-eaters out of the leaves from a large branch.

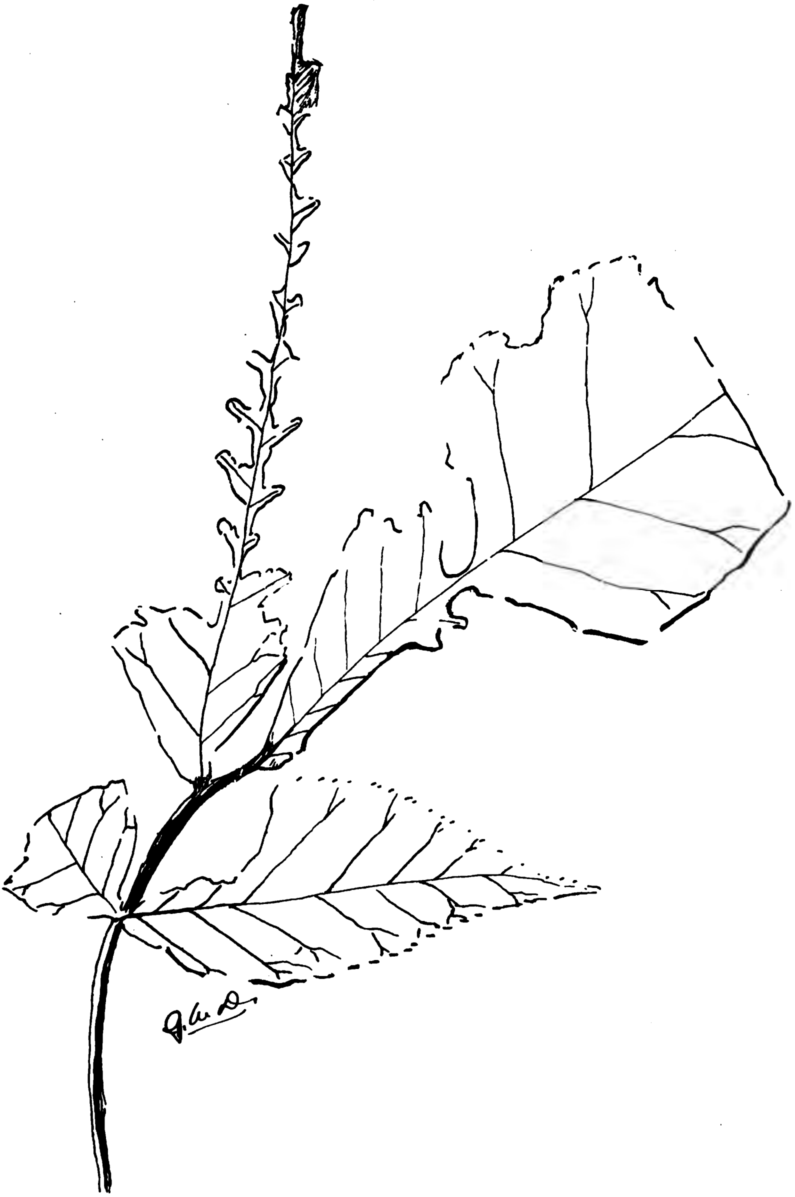


Fig. 26. Hickory leaf injuries.

LEAF ROLLERS.

(Tortricidae Leach.)

Small-sized moths, rarely expanding more than one inch, and the wings are folded roof-like over the body. Some species are of very brilliant color. They fly mostly at night and rest during the day upon the plants which serve them as food. The larvae are cylindrical and nearly naked. Many of the species roll up the leaves, others just fold up one side, while still others bind several together. Many devour the interior of fruit buds or live on the tender young shoots. Oaks were found to be the most affected, but the work of the leaf rollers was apparent on the elm, hickory and beech. Fig. 27.

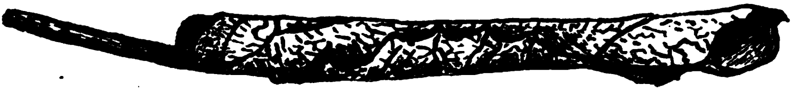


Fig. 27. Work of leaf rollers upon a rock chestnut oak. (Quercus Prinus.)

TWIG WEEVILS.

This is a class of snout beetles which deposit their eggs in the dead and dying twigs of trees, and the larvae mine into the leaves and pith. When they infest the twigs of living trees they often do a great amount of damage. This insect worked much in the pith of the hickory twigs and in a few cases was responsible for the ruin of the tree.

HICKORY BARK BEETLE.

(Scolytus-4-spinosus.)

A shiny black or reddish-brown beetle about .14 of an inch in length. The male armed with four rather prominent spines. It appears upon the wing from May to August and begins its attacks upon the living trees at the base of the buds and leaves. Later it enters the bark of the larger branches and excavates short, longitudinal burrows in the inner bark and surface of the wood. The eggs are placed in burrows alongside of the primary gallery and hatch into small, white grubs. The larvae pass the winter under the bark and emerge in the spring as adults through small holes made in the outer bark. These continue their depredations upon other trees or the remainder of the trunk not killed by the first attack.

The adults will be found attacking trees any time from May until August. The first indications of their presence will be the wilting of the leaves upon some of the twigs or branches, and if the bark be peeled off, their characteristic galleries will be found.

As there is but one brood annually, and this passes the winter in the immature stage in the bark, it should be comparatively easy to manage this pest where taken in hand in time. To do this all the trees which are infested should be determined at the beginning of the winter and see that these are cut and the bark burned before the following May. If this plan is followed and the infested trees are treated in this way, the number of insects will be so reduced that they will be unable to continue their depredations upon living trees. Many hickory forests in different parts of the country have been utterly ruined by this pest. We are unable to find them in any part of the Reservation.

LOCUST BORER.

(Cyllene Robiniae.)

This beetle is so destructive that it makes the growing of locusts impossible in many localities. The beetle appears in the fall, lays its eggs on the bark, and the larvae bores under the bark and into the hardwood in all directions. The adults feed upon the pollen of the golden rod and may be found there in great numbers. As soon as the tree attains any size, it is riddled in all directions by the hungry larvae and after leading but a sickly life for a time dies down to the ground.

The beetles are black, with numerous transverse, wavy, yellow bands. We have no remedy to suggest except the general remedy for all boring beetles, cut out and burn all the affected trees.

ANIMAL LIFE UPON THE RESERVE AND ITS RELATION TO INSECT FORMS.

The birds reported upon the Reservation between the dates of June 20th, and July 12th, following:

Flicker (Yellow Hammer).
Downy Woodpecker.
Red-head Woodpecker.
Hairy Woodpecker.
English Sparrow.
Field Sparrow.
Chipping Sparrow.
Ground Sparrow.
Song Sparrow.
Fox Sparrow.
Tree Sparrow.
Grass Sparrow.

Vesper Sparrow.
Meadow Lark.
Little Meadow Lark.
American Robin.
Marsh Robin.
Bluejay.
Catbird.
Brown Thrasher.
Wood Thrush.
Cardinal.
Black-poll Warbler.
Magnolia Warbler.
Yellow Warbler.
Carolina Warbler.
Maryland Warbler.
Cerulean Warbler.
Pine Warbler.
Long-tailed Wren.
Sport-tailed Wren.
Bemick's Wren.
Cherry Bird.
Cedar Bird.
Barn Swallow.
Bank Swallow.
King Bird.
Butcher Bird or Shrike.
Chickadee.
Crested Flycatcher.
Blue Bird.
Indigo Bird.
Whip-poor-will.
Mourning Dove.
Shitepoke, or Thunder Pumper.
Red-eyed Vireo.
Belted Kingfisher.
Peter Bird.
Golden-crowned Kinglet.
Ruby-crowned Kinglet.
Goldfinches.
Yellow-breasted Chat.
Pee Wee.
Sapsuckers.
Nuthatchers.
Humming Birds (2 varieties).
Quail.
Common Pheasant.
Mongolian Pheasant.
Partridge.
Grouse (few).
Wild Turkey (very few).
Red-shouldered Hawk.
Cooper's Hawk.
Sparrow Hawk.
Crow.
Red-winged Blackbird.
Screech Owls (2 varieties).
Great Owl.

No complete list of animals was kept, as the season was not good and the time spent was too short for a thorough study. However, a close watch was made while working out the insect relations and such material as possible was gathered from reliable sources. There may be some reported below which may not have been here at the time, or others which were present and were missed, but in the main we have a fairly complete list of the more numerous forms.

Raccoon.
Opossum.
Red Squirrel.
Gray Squirrel.
Fox Squirrel.
Ground Squirrel.
Ground Hog (Woodchuck).
Red Fox.
Rabbit.
Lizards (3 varieties).
Bull Snake.
Milk Snake.
Garter Snake.
Grass Snake.
Green Snake.
Black Snake.
Blue Racers.
Moccasins.

Glass Snake.
Spreading Viper.
Timber Rattler.
Copperhead.
Common Toad.
Tree Toad.
Green Frog.
Bull Frog.
Norway Rat.
White-footed Mice, or Field Mice.
House Mice.
Shrews.
Mole.
Box Tortoise.
Pond Turtles.
Red Bat.
Serotine Bat.
Grayfish.

In the preceding list no attempt has been made to put special effort upon the forms, it was our chief aim, rather, to gather some information of the fauna of the Reserve, while making a study of the insect life. With this list of the more numerous forms we may be able to show that the life relation is here maintained in much the same manner that it is in other remote parts of the State.

Too much importance can not be attached to the place held by animal forms in the life histories of insects. Nearly all men who know the woods and fields know when an animal form is injurious or beneficial, that is, to a certain extent, but many wage warfare upon a form which is doing a small amount of damage, when in the main it is highly beneficial. Much has been said and written about the depredations of the man and the gun. Legislation has been made against killing certain bird forms. This certainly does no harm and it may perhaps promote a feeling of forced humanity, but the man and the gun, or a thousand men and guns would be, so to speak, only a drop in the bucket compared to the havoc worked by great ranges in the comparative amount of rainfall, sudden changes in temperature or a long, hard winter. Particularly is this so of ground nesting birds, and as a rule these birds are the timber's best friends. The number of insects devoured in a day by a single quail or pheasant is almost incredible. Often a few of those eaten may be beneficial, but in the main in some stage or other of their life they prey upon growing crops and vegetation.

The common toad is an excellent destroyer of insects of every variety. From his secluded spot under a leaf or in the shade of a pile of sticks he captures bug after bug, which, left to multiply, would ravage several acres. Data has been compiled to show how many flies, etc., a toad would eat in a day, but these figures are far from accurate, as a toad in captivity with food supplied and a toad seeking its food in the open, are clearly not comparable.

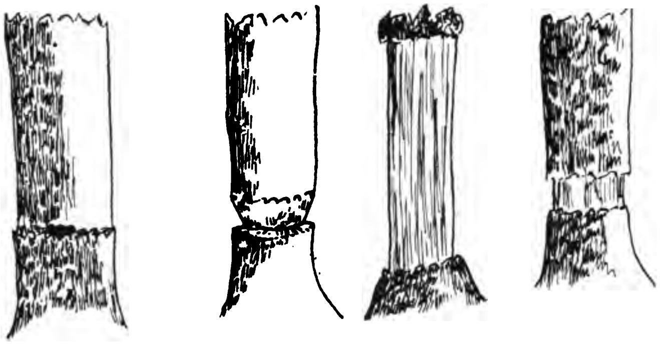
Equally beneficial is the mole. Burrowing beneath the ground from place to place in the heavy mulch, under rotten logs, he seeks out and destroys whole colonies of healthy grubs and industrious pests.

The whip-poor-wills, night flyers, do their share of insect destruction while most of the arboreal birds doing nominal damage more than pay for it by their zealous quest of insect food.

One of the greatest animal pests upon the Reservation were the squirrels. Where seeds had been put in, replanting was necessary in a majority of cases, all this on account of the active work of these rodents. The large amount of food at hand, together with the activity of Mr. Claude Holton, the Reservation game warden, have produced conditions actually menacing to seed growth of all kinds. The nurseries were still too small and out of season to attract the attention of rabbits, but from the large number of these rodents seen we would predict no little trouble from them in the future.

It is, therefore, obvious that before war is declared upon a form doing noticeable damage, its relations to other forms be ascertained in a measure at least. With indeed scarcely an exception we would advise that as far as possible for the benefit of timber lands, letting the animal life put forth its best efforts for maintenance; it being a well known fact that when this area was covered with a luxuriant virgin growth of trees, game of all kinds was most plentiful.

A series of experiments conducted by the Government Forestry Bureau during the summers of 1900 and again in 1902 resulted in the discovery that if living spruce trees were hack girdled (Fig. 28) just before the pollen commences to fall from the red spruce, and when it is falling from the birches, the conditions as related both to the flight or swarming period of the beetles and to the physiological phenomena of the tree, will be most favorable to the attraction of beetles to such trees. Thus the beetles may be made to concentrate their attacks upon numerous girdled trap trees, to be subsequently destroyed during the fall, winter, and early spring months either by the ordinary lumbering operations, which insures their removal from the forests before the insects emerge, or by felling the trees and removing two-thirds of the trunk, this method to be supplemented as far as possible by the felling and barking of such other trees as are found to be infested. By this means, the number of beetles may be so reduced within large areas as to effectually protect the remaining living timber. It was also determined that the adoption of improved forestry methods, which require the intelligent harvesting of the matured crop of timber, is doubly beneficial to the forest. These methods involve the removal of trees above twelve inches in diameter and a leaving of the younger growth to produce a future supply of timber.



a. b. c. d.

No. 28. Different methods of girdling trees.

a. Hack girdled. b. Girdled to heartwood. c. Hack girdled and peeled. d. Belt girdled.

(From Bulletin No. 28, new series, Division of Entomology, U. S. Dept. Agr.)

REMEDIES.

There are three general classes of remedies for injurious insect pests, viz: (1) A poison which must be taken into the system. (2) Killing by contact. (3) Prevent access.

Three general ways in which insects feed, viz: (1) Eat openly and chew their food (caterpillars and leaf-eating beetles). In this case, the first and third remedies must be used. (2) Puncture the plant and suck the juices (plant lice and plant scales). For this the second and third remedies may be used. (3) Internal feeders (borers). For this the only remedy is the third.

The first and second remedies, while they are practical for the shade trees and orchards, are not so for the large forests.

Thus we have only the third left to use in forestry of this kind. While we have all the different classes at work, we must use a common remedy and prevent their access and gaining a foothold. The rigid application of the main principles of modern forestry in regard to insects will, as a general rule, keep in check all of the pests now present on the Reservation. In the case of all borers after an entrance is once effected there is nothing that can be done, except to cut out the affected tree. The best preventive is to keep the woods in the best sanitary condition possible, with relation to insect breeding places, and with the help of the natural insect enemies (other insects, birds, reptiles, etc.) they will be kept in check. Trees blown down by storms or felled by the axe attract vast numbers of species. Some live in the bark, where they do little or no damage to the commercial product, but others may multiply rapidly and center their attacks upon standing timber. The wood, however, may be seriously injured by many species of bark-boring beetles, and grubs which live only in the wood of dead and felled trees. Old dead, standing and felled trees, logs and stumps, are infested by many insects which not only contribute to the rapid destruction of the wood, which otherwise might have some commercial value, but certain varieties breed in such material and emerge to attack the wood of recently felled trees and injured parts in standing living trees.

If the bark is peeled from pine logs immediately after cutting or likewise in the case of the hickory, there will be very little damage done. While it is true that there are many destructive pests not present on the Reservation and other Indiana forests, at the present time, it is altogether probable that they will appear at various times, and for this reason a sharp lookout should be kept at all times and where a new form is suspected it should be studied and dealt with in ways suggested by the circumstances under which it is working.

The subject of fungus or contagious diseases of insects is an interesting one, but it must be dismissed here with only a brief reference. We know that insects often suffer from disease, and that epidemics sometimes occur among them that destroy myriads. Some of the diseases have been studied and attempts have been made to use these diseases in a beneficial way for man. That is to man's advantage. Thus if a great pest appears, some of the insects are sent to an experimental station where they are innoculated with a disease peculiar to them and peculiarly contagious. They are then sent back and turned loose among their kind where it is expected that the disease will spread and rapidly exterminate the previously healthy insects. This is very good where the weather conditions are all right, but where too much or too little moisture prevails the results are said to be far from satisfactory.

An example is the experiments which have been conducted with a view to exterminating the chinch bug.

CONCLUSION.

If the conditions existing in the Forest Reserve can be taken as typical of the conditions throughout the State, the following conclusions may be drawn:

(1) The trees most liable to insect attacks are: Oaks and hickories.

(2) The parts of the trees most seriously affected, not referring to the trees' vitality, are, in order: Trunk, bark, branch, twig, and leaf.

(3) The insects causing these damages are: Borers, leaf-eaters, bark beetles, twig girdlers, cicadas, pruners, engraver beetles, twig weevils, leaf-hoppers, tree-hoppers, leaf rollers, plant scale, many species of the Lipidoptera, which includes all caterpillars.

In other portions of the State, reported are: Cottony maple scale, San Jose scale, elm-leaf beetle, locust borer, hickory-bark beetle. These may be found in localities doing nominal damage, but we did not find any trace of them upon the Reserve. Other insects may appear from time to time, but no great damage need be expected relatively soon.

RECOMMENDATIONS.

1. The protection of natural enemies of these insects. These are: Insectivorous insects, birds (before mentioned), small mammals, reptiles, toads and frogs.

2. Artificial methods: All rules regarding the sanitary condition of forest lands should be regularly followed, viz:

a. All saplings should be at least three and one-half feet apart.

b. All unhealthy stump growths should be cut out.

c. Remove underbrush.

d. Remove all unhealthy, dead, dying and decayed timber and burn.

e. A variety of trees should be planted.

3. An experienced entomologist should be permanently stationed upon the Reservation in order that each new attack may be studied and checked, thereby keeping the conditions more nearly normal. By this means, the tests of years upon forest growths will be accurate and beneficial to the lumber-men of the State.

4. After a careful study of the topographical conditions at the Reservation, the most important work to be done is to put the forest area in a sanitary condition more conducive to healthy growth. To do this, our estimate, under present conditions, is $4.75 per acre of timbered land.

The young trees as a rule are putting forth their most healthy growth, the land is in the best condition it has been for years, and a careful watch kept over the insect pests and a general clearing up of the area, the Reserve must, out of the natural order of things, stand as a representative forest of the first class.

June 12, 1905.

Some Trees to Plant for Railroad Ties, Fence Posts and Line Construction Poles.

The kinds of timber which have been almost exclusively used for these purposes is rapidly becoming exhausted, and an effort must be made to meet the future demands by growing them under cultivation. Farmers are finding difficulty in securing good fence-posts at reasonable prices, railroad companies are resorting to inferior grades of timber and treating them chemically to supply them with crossties, and line construction companies are compelled to pay fancy prices for poles used in telephone and telegraph line building, and every sign indicates that the demand will be larger as years pass. Farmers can meet these demands at good profit by cultivating a part of their land to timbers suited for these uses.

The trees given here are some of the best for these uses and are all rapid growers.

CHESTNUT.

The natural range of the chestnut is from southern Maine to the Gulf of Mexico. It thrives well throughout the Mississippi Valley.

The soil best suited for the growth of the chestnut is retentive clay containing some sand or at least porous. It does not demand a rich soil and does excellently on old, abandoned fields. The chestnut will endure the heat and cold of the temperate climate and will grow very well in sunny, dry situations.

The wood of the chestnut is light, strong, coarse-grained and inflexible. It splits very readily and is exceedingly durable in contact with the soil. It is used in cabinetmaking and for interior finish. In all sections of the country it is prized very highly for use as railroad ties and telegraph poles. It makes very durable posts, and is also valuable for shingles. Its rapid growth and tendency to reproduce by coppice makes it a valuable tree for these uses. The chestnut grows very rapidly on good situations. The trunk of the tree grows tall, tapering, and free from limbs.

The chestnut reproduces from seed and from sprouting from the stumps after cutting off. The growth from stumps with good root systems is very rapid, and cuttings can be made about every twelve years. The seeds ripen at the time indicated in a preceding article and they may be planted as soon as mature or may be stored and planted in the spring. It can be grown well from seedlings, as they bear transplanting successfully. The best distances to plant are 4x4 feet or 6x3 feet.

I consider this one of the finest trees for farmers to plant, because of its clean nature, lasting qualities for all the uses given and its ease of cultivation. The trees should be pruned when young to form the correct boles.

CATALPA.

The Catalpa Speciosa occurs naturally on the deep, fertile soils of the valleys of southern Indiana, Illinois, western Kentucky, Tennessee, southeastern Missouri, northern Mississippi, Louisiana and northeastern Texas. In the most favored localities it attains a height of from 60 to 80 feet, occasionally reaching 100 feet. The diameters range from 2 to 4 feet. This has proven to be a valuable tree, hence at the present time has become exhausted along with the other valuable kinds, so that now it is rare that a fine tree can be found. It is capable of a much more extended range than is given it. It has been successfully propagated as far north as 41 latitude and as far west as 100 longitude. I do not believe that there is another tree capable of stronger soil adaptation than the catalpa. It is especially adaptable to deep, fertile, porous soils, and thrives well when there is an underflow of water within 10 or 12 feet of the surface, even in slight rainfall. Because of these attributes it is successful throughout Indiana, with the exceptions of the stiff clay soils, and a mistake will be made if it is planted on such soils, no matter haw much attention and care may be given it.

The catalpa is a rapidly growing tree, when congenially located, for a period of 50 years and more. From 15 to 25 years are required to grow trees suitable in size for telegraph poles and railroad cross-ties, while for fence posts from 8 to 12 years are required. Plantations favorably located have returned great profit. Some of the following are instances of the returns: The George M. Munger plantation, Eureka, Kansas, averaged at 13 years a net annual profit per acre of $15.01; the H. H. Hunnewell plantation, Crawford County, Kansas, averaged at 18 years a net profit per acre of $26.47; the L. W. Yaggy plantation, Hutchison, Kansas, averaged at 12 years a net annual profit per acre of $21.55. In all these instances the stock for planting was purchased, the planting was cultivated for two years and paid for. Every expense, including 6 per cent. interest on the investment was counted and deducted from the gross earnings.

It is most readily propagated from seed sown in the nursery in the early spring. The seed can be easily obtained from seedsmen. They ripen in October and can be gathered and safely kept through the winter in a cool, dry place. The nursery site should be of rich, mellow soil finely pulverized. The nursery rows should be for hand cultivation, 18 inches apart, but for horse cultivation they should be 3 feet apart. If the proper attention is given the nursery, the seedlings will be sufficient size for planting the following spring. Owing to the fact that it is difficult to grow the catalpa with straight boles, extra caution must be taken to force the right form of trunk. It should be planted at distances of 4 by 4 feet or 6 by 3 feet, and not to exceed 5 by 5 feet under the most favorable conditions. The tendency of the catalpa seems to be to branch and crook in growing. If it is planted closely, the lateral branches die before they attain any size and are easily pushed off without causing any damage, but otherwise they remain and cause permanent damage to the body of the tree. New wood is formed around the branch and thus leaves a hole into which water is conducted and the tree becomes affected by rot in the heartwood. In addition the close planting causes them to grow up in search of light and thus checks the tendency to crook. The difficulty to straight trunks is the serious drawback to the catalpa. The surest method for overcoming this evil is to cut the trees back to the ground at the end of two or three seasons' growth. The extensive root system formed will cause vigorous sprouts to put up from the stump. In midsummer following the cutting back, they should all be removed but the one most thrifty, which if left is soon forced upward in a long straight bole, free from the numerous branching. At the end of the same time a great advantage is gained by doing this, though it may appear like destroying the two or three years' growth. It can be grown successfully in pure or mixed plantings with the walnut, locust, ash or Kentucky coffee tree. In case planters do not care to grow seedlings for planting, there are nurseries throughout the West which grow them for wholesale planting at very small cost per thousand.

There is difficulty in planting the catalpa by not being able to distinguish the varieties. There are at least four different species, two being shrubs and two fully developed trees. The Warder Speciosa or hardy catalpa can be distinguished as follows: The leaves are from 5 to 12 inches long, heart shaped, long pointed; the flowers are about 2 inches long, nearly white, faintly spotted, the lower lobes somewhat notched; the bark is rough and thick. The other species (Catalpa Bignonioides) which is also a large tree, has about the same shaped leaf, but has scaly glands in the axils of the large veins on the under side, entire, usually, angulated, opposite and sometimes in groups of threes, very downy beneath when young; the flowers are much spotted with yellow and purple and with the lower lobe entire; the pod is long and thin; the bark is lighter in color and not so rough and is thin. The other kinds are mere shrubs and at no time could be mistaken for the larger kinds. The former one is the tree to plant for economic uses, though the other kind will give fair returns in durability.

There are two forms of disease which infect the catalpa, the wood rot and the leaf blight. The wood rot may be classed into kinds, the soft and the brown rots. Both are caused by the decay of limbs which are left on the tree till growth takes place around them, thereby leaving holes into which water is conducted as heretofore mentioned. The remedy is to prevent any such conditions by pruning and daubing over the cuts so that fungi spores can not get in to form such rot. Right planting, pruning and treatment by daubing the cuts made will avoid such difficulties. The blight of the leaves is due to the larvæ of Diplosis, a gall-gnat. The affection is evident by the leaves, shoots and buds turning black, shriveling and dying. Trees which are affected several years in succession show the effects by the numerous sprouting of limbs and trunks. No good remedy is known at present.

KENTUCKY COFFEE TREE.

(Gymnocladus dioicus.)

The natural range of the Kentucky coffee tree is the northern two-thirds of the Mississippi Valley. This is one of the rarest trees of North American forests. Its range for economic planting is coincident with its natural range. It should be planted much more frequently in the future than in the past. In barren soil, it is a slow-growing, long-lived tree. In fertile river valleys it grows more rapidly. It produces the best results on the richest bottom lands, but will thrive on sandy or gravelly uplands. This tree will endure the most extremes of climate.

The wood is heavy, moderately hard, coarse-grained, strong, and very durable in contact with the soil. The sapwood is thin and the heartwood of a rich, reddish-brown color, is very suitable for cabinet work and interior finish. The timber is but little known at present.

The Kentucky coffee tree sometimes attains a height of 100 feet and a diameter of 3 feet, but it is usually much smaller. The trunk usually possesses a very uniform thickness and is tall and free from limbs.

This tree reproduces from seeds which are borne in pods by the pistillate individuals in great abundance. In starting a forest plantation of this species, it is much better to plant the seeds in nursery rows and transplant the trees into the final forest site at the end of one year than to attempt to grow the trees from seeds planted in the permanent site. The Kentucky coffee tree develops a root system which adapts it to transplanting.

The pods should be collected in the late fall and macerated in water to remove the seeds. After the seeds have been separated from the pods and dried reasonably, should be stored in sand to weather.

The rules for planting the coffee tree are the same as for the locust and chestnut.

The Kentucky coffee tree is a light-demanding species. It can not keep the grasses and weeds in subjection when planted alone, owing to the open nature of the foliage and to its habit of leafing out very late in the spring. In nature it grows associated with the ash, walnut, hickory and elm. When making a forest plantation of this species it should be mixed with such trees as the white elm, red elm, hackberry, oaks and ashes. If planted several years previous to its associates, it may be mixed with hardy catalpa, Russian mulberry or black locust. The growth and habits of this tree in the Southwest are very similar to those of the walnut. It can be substituted for the walnut in almost any planting or use.

BLACK LOCUST.

The black locust was originally indigenous in the mountainous regions from Pennsylvania to Georgia, and occasionally Arkansas and eastern Indian Territory. But at the present time, through cultivation and other agencies, it has become naturalized throughout the United States east of the Rocky Mountains. It is appearing naturally abundant upon abandoned hillsides in the States of Pennsylvania, Ohio, Indiana, Kentucky and in the southern portion of the plains west of the Mississippi to the mountain slopes. It is associated with other deciduous trees in the form of small scattering groves.

There is an objection offered against the black locust on account of its sprouting and spreading tendencies from the root. I do not consider this a sufficient cause to militate against the planting of this tree for economic purposes. A casual observation will convince that most any tree does equally as bad, but nevertheless caution should be taken to confine it where planted. The seeds should not be allowed to become scattered over the farm by being hauled out in the manure or otherwise. A row of osage, soft maples or other dense shading trees planted around the locust planting will prevent spreading.

The growth of this tree is very rapid in all rich, loose soils. It attains its maturity at about 50 years and the usual size is about 80 feet in height and from 2 to 3 feet in diameter, depending largely on the distances planted as to its trunk formation. The largest and quickest matured specimens are found in deep, loose clay, valley and bottom-land soils, though it grows successfully on poor soils if sandy or gravelly, and it is shown to be the most durable wood when grown on such lands. The locust should never be planted in hard, wet, clay soils as its roots are surface spreading and draw nourishment from the surface, and hence in such soils can not penetrate sufficiently to insure a good strong growth.

The black locust is finding extensive use for posts, ties, telegraph poles and vehicle manufacture. Its great durability in contact with the soil, its toughness and elasticity of fiber make it valuable for these uses. A post from 6 to 8 inches in diameter can be grown in from 10 to 12 years in good soil. Unlike many other timbers, the young wood is almost as durable as the old. Posts of such character last from 12 to 20 years, though extremists say much longer. This tree is a most valuable one for fuel planting.

The planting, to secure good results, should be close, 4 by 4 feet or 3 by 6 feet. They should be pruned when young to aid in forming straight, long boles. Every effort should be made to keep the trees thrifty and growing, to prevent attacks from borers. To this end the grass and weeds should be kept out till the growth is large enough to protect itself. The planting should be watched to make trimmings at the proper times to prevent the decay and injury by crowding and smothering. A thrifty growth is seldom attacked by borers. The locust grows will in mixture with the catalpa, elm, ash and walnut.

The black locust is propagated from seeds and root cuttings The seeds retain vitality for years if kept in the pods or buried deep in the ground, 7 years having been known to find good vitality remaining. The seeds ripen in July and August and may be planted at once or kept in storage till spring and then sown in nursery rows. The seedlings should be propagated in the nursery bed and transplanted to the permanent places in the plantation the following fall or spring. If the nursery is to be cultivated by hand the rows should be from 15 to 18 inches apart, but if by horse cultivation the rows should be 3½ to 4 feet apart. A pound of seed contains about 2,800 in number and is sufficient for a row of nursery 900 feet long. The nursery site should be in rich, pulverized loam. To secure the best degree of seed germination the same year they are planted they should be treated to soften the stone shell of the seeds. The seed should be removed from the pods and kept stored by placing in boxes, stratified in layers of sand, kept moist during the winter until time to plant. They may be placed in a box or bag and buried in the ground so that water will not settle upon them, and let them remain until time to plant in the spring. Freezing and thawing will add benefit to the result.

Nursery-grown seedlings can be secured at very low cost per thousand from reliable firms engaged in growing forest tree stock for wholesale planting. Any seed firm can secure the seed for its patrons.

I do not anticipate that there are many who do not distinguish the black from the honey locust, but I have frequent enquiry concerning the differences of these two trees. In short the characteristic differences by which they may be known are as follows: The black locust has reddish-brown, rough bark, broken in ridges; the leaves are compound, alternate, rounded at both ends, entire netted-veined, occasionally tipped with the end of the midrib and covered with silvery short hairs when young; the flowers are white, fragrant, and in loose axillary racemes; the seedpods are linear, smooth, short, contain from 4 to 6 brown seeds and hang on the tree over the winter. The honey locust has rough, gray bark broken into scales at the base of the trunk; the young branchlets are a deep reddish-brown; the leaves are compound, alternate with long, downy leaf stalk, smooth, green above, yellow below and from ten to twenty long oblong leaflets tapering towards the apex and rounded at the base; the flowers are greenish white and grow in narrow racemes; the seed pods are from 9 to 20 inches long, reddish-brown, flat, linear, curved, contain between the seeds a sweet substance and seldom hang on the tree during the winter.

The honey locust is usually very thorny, while such is seldom the case with the black locust.

OSAGE ORANGE.

The osage orange thrives well throughout the same range as the chestnut, though it has been more widely introduced by cultivation. The soil best suited to its growth is deep, rich, clay loam, retentive of moisture.

It has been extensively planted for hedge throughout the Central States, but it should be more frequently planted as a timber tree. It sometimes gets winter killed in the northern part of this State.

The growth of the osage for the first few years is very rapid. It never makes a large tree, and matures in a reasonable period of time. The tree when standing alone has a tendency to branch very profusely. It is this habit which renders it of such great value as a hedge plant. If crowded, it can be made to grow into a form which adapts it for posts. The osage orange reproduces by sprouting from the stumps, from the roots and from seeds, which are borne in great abundance by the pistillate individuals. The ripe fruit containing the seed is a fleshy, globular, yellow mass with roughened surface, somewhat resembling an orange. The fruit should be collected in the fall as soon as ripe, macerated and the seeds washed out and stored in sand. Seedlings of this tree can be bought cheaper than any other kinds from nursery firms.

A good method of planting the seed is in the bottom of a furrow made by a plow. They should be covered about an inch and a half deep. The seeds may be planted where the trees are intended to stand, or they may be planted in a nursery and the trees transplanted to their final site at the end of one year. The right distances of planting are same as the chestnut.

The osage orange reproduces from coppice very readily. This quality allows the planter to continue to take successive crops of posts from the same plantation for years. The young shoots grow up from the stump with such vigor that the second crop is more likely to consist of straight, smooth post timber than the first crop.

The osage orange is a shade enduring tree. The thorns of the tree make it often undesirable to plant. The osage orange does well in either pure or mixed plantations. In this way thick planting may be practiced and the need of inner tillage reduced to a minimum.

BLACK WALNUT.

The range of the black walnut is west from Massachusetts to Kansas and south to Florida and Texas, covering practically the middle Atlantic, Central, Southern and a portion of the New England States. It was formerly abundant throughout this range, and is undoubtedly a sure tree for economic and commercial plantings in the Mississippi Valley from Minnesota southward. The soil best adapted to the growth of the walnut is fertile alluvium containing large quantities of humus. It thrives best in porous, open subsoil, such as is found in low river bottoms. The walnut is subject to injury by exposure to hot winds and extreme cold, therefore, some judgment should be exercised before planting it in the northern, southern and western ranges, though any part of Indiana, climatically, is free from such influences.

The wood of the black walnut is rather heavy, hard, strong, rich dark brown color and easily worked, hence highly prized in fine finish and cabinet making. It is also a lasting timber in contact with the soil. The walnut is a rapid growing tree in good soil. At maturity it attains a diameter ranging from 4 to 6 feet and an average height of nearly 100 feet. No other tree excels it in clear straight trunk when planted in close proximity, 4 by 4 feet or 6 by 3 feet. The walnut matures to good value in 20 years, though the best value is not below 40 or 50 years. It grows rapidly for the first twenty years, but a great amount is sapwood, but from then on the growth is slower because the sapwood is transforming into heartwood and the older the tree becomes the more valuable it is. No walnut plantings have been made and harvested from which to estimate the value per acre to the planter, but from all theory involved it surely is a safe financial enterprise.

The walnut is best propagated from the seed planted in the fall of the year and stored by stratifying in the ground or in dampened sand in boxes till spring, and then planted. The stratification should be where the seeds may be exposed to freezing and thawing in order to soften the stone shell and insure quick germination. It will do well in mixed plantings with the elm, oak, ash, hickory, locust, poplar and maple, if care is exercised to prevent its being shaded out or overtopped. When planted at the distances indicated above and thinnings properly made to secure thrifty growth, I feel confident of the financial success of the walnut planting.

WILD CHERRY.

The range of natural growth for the wild black cherry is from Nova Scotia westward to the Great Lakes and to the Dakotas and south to Florida and Texas. It, like the black walnut, thrives best in the middle Atlantic and Central groups of States, but is not found so abundantly in the open prairie. In the dense forest regions of the natural range the cherry was formerly a conspicuous part of the forest growing on the rich soils, but like the other valuable hardwoods it has been sought to the almost complete exhaustion of the valuable trees at the present; especially is this so in Indiana.

The range of the economic planting of the wild cherry is extensive, though nowhere is it surer of successful propagation than in Indiana, but seeds and seedlings of southern acclimation will not thrive in northern latitudes. Such, however, is not the case with seeds and seedlings northern acclimated. By observing this caution, the bad winter killing of many wild cherry economic plantings of northern sections can be obviated.

The wild cherry is a rapidly growing tree, though short-lived, hence a splendid tree to plant in mixture where thinnings are necessary to make room for the expansion of the longer-lived kinds. In timber regions it grows to considerable size, forming a long symmetrical trunk, making it a valuable tree for saw and veneer mill purposes. In economic plantings it should be planted at close distances, 4 by 4 feet or 6 by 3 feet, in order to force a long bole, and then many thinnings for the expansion of the remaining trees. The wood of the cherry is a reddish-brown color, hard, fine-grained, durable, strong, heavy and takes on a fine satiny polish. Because of these qualities it is sought for fine interior finish and cabinet-making.

This tree propagates readily from the seeds, which may be sown as soon as ripe in the fall, or they may be stratified and allowed to freeze during the winter. The manner of stratification is the same as indicated in the discourse on the black walnut. The seeds can be planted in the site where the tree is to grow, or they may be planted in nursery rows and transplanted to the permanent sites when the seedlings are one or two years old. I recommend the storage process for the seeds and the nursery planting as against the direct planting of the seeds in the permanent sites. It is a light demanding tree, therefore should not be planted in mixture with trees that will outgrow and overshade it. It can be safely planted with elm, walnut, locust, birch and ash.

Seeds and Seedlings for Forest Planting.

The planting of new forests is a thing which will greatly concern the people of Indiana in the very near future. Without doubt it will command much attention in certain parts of the State where the conditions are better adapted to timber culture than most any other thing in which the people might engage. There may be many ways in which such work may be performed, but the simplest and most effective methods of planting from seeds and by homegrown nursery seedlings is recommended as giving the most satisfaction. These methods are inexpensive, and make planting possible on a large scale with small means. The following discussions may suggest some things of value to guide those who wish to engage in planting.

SEEDS.

It is very important to procure and use only good seeds in planting. This is essential to secure a stand and to prevent a waste of time and labor. The quality of seed depends largely on its being perfectly matured, the size, the age and the location in which grown.

In the instance of one and the same species of seed, the larger, heavier and mature ones are better than the smaller weakly ones. None but the former should ever be selected, because they possess greater germinating power, are more vigorous against hindering conditions of every sort. They have a greater reserve of material to aid development, the same as good seed of wheat, corn or any other agricultural product. This fact may be traced on through the life history of the tree from such seeds. In cases of tests the dominant tree grew from the perfect seed.

The quality of seeds can sometimes be tested by the external appearance, but not always. Good seeds fill entirely the outer shell, are of a live, rich color and smell strongly of the characteristic odor of the tree. In all cases of heavy seeds, where it is not desired to trust to the senses of touch, sight and smell, they may be tested by throwing them into vessels of water, when the well-developed seeds will sink and the inferior ones will float.

The germinating power of seeds is greatest just when it has ripened. It may be retained for a time, according to the species, and in case of proper treatment can be retained in perfect vigor. Some seeds must be planted immediately upon maturing, while others can be kept for some months. It is well known from natural information that all seeds ripening in the autumn do not germinate till the next season. Under favorable conditions the seed may be planted in the fall as soon as they mature, but owing to climatic uncertainties it is better to store and plant in the spring. The best time for planting in the temperate climates is April and May.

That the late maturing seeds may be kept in good condition, they should be properly treated and stored through the winter by either the earth or cool dry processes, according to the requirements of the seeds. The nuts and acorns should be divested of the hulls and cups, the cones and pods should be dried and the seeds whipped out, or the seeds may be allowed to remain in them, and the fruits should be macerated and the seeds washed out. All those requiring earth storage should be reasonably cured in the open air and light (never by fire heat), and then stored.

The manner of storing in earth is very simple. Select a well drained site and excavate to a depth of eight or ten inches, and as large as required for the quantity of seeds. Place within the excavation alternately layers of seed and earth till all are stored, cover to a depth of five or six inches with dirt, arrange the drainage so no water will stand on the seeds, and let them alone to freeze and rot till time to plant in the spring. To store in boxes is very similar. Secure boxes of such size as are needed to hold the quantity of seeds in storage, fill the boxes with sand and seeds in alternate layers, bury the box in the soil on a well drained site as in the former case and let remain till time to plant. Another method is to arrange plank boxes on the surface and store the seeds in either earth or sand as before and allow them to remain till spring. It will be found necessary to guard against rodents destroying seeds in storage as well as after planting.

When seeds are treated in the ways thus described, and if no water is permitted to stand on them, the weathering thus afforded them is the thing they need to soften the shells and insure prompt germination when planted. When the seeds are removed from earth storage they must be planted at once and not allowed to dry out, as that will destroy the life germ.

The trees the seeds of which ripen from September to November, inclusive, and need earth storage, are the following: Oak, hickory, ash, walnut, sugar maple, locust, chestnut, plum, cherry, persimmon, dogwood, hackberry, beech, lin, osage orange, and black gum. The trees the seeds of which ripen from August to November, inclusive, and need storage in a cool, dry, airy room are the following: Canoe and sweet birches, catalpa, sassafras, mulberry, sweet gum, poplar, cottonwood, cypress and pine. Those the seed of which ripen in May and June, and must be planted at once, are the following: Elm, red birch, red maple, and ironwood.

The trees from which seed should be gathered and the locality are two matters which should be considered. Though all aged trees may and can yield good seed as a rule, it is better to select seed from trees which are in the prime and vigor of growth and possessing full crowns. The seeds should be selected from a locality of the same soil and climate as the area to be planted, say some authorities, while others disclaim the idea and think that the same thing prevails in this as does for seed in agriculture, and that different soils and climates should be considered in seed selection. Seeds should be secured which are good and thrifty and from trees sound and in the best growing state, and I am of the opinion that the other facts will not count for much, though with the buying of seedlings it would be quite different.

The trees best to gather from, both for good seed and convenience, are those growing in the open. The seeds of the extreme early and late ripenings should not be gathered, but the middle maturing should be selected. The tree should not be cut to secure the seeds, but shake them down and let the tree remain.

When the right season and conditions of spring come for planting, the seeds can be removed from the storage and thrown into vessels of water to clean them and detect the bad seed before planting. The storing process usually reveals the inferior seeds by their decayed and black appearance from the freezing and rottening effects of the storage. If the seed are to be planted in a home nursery to grow seedlings for transplanting, the nursery site should be selected and prepared for the seed before they are taken from storage.

THE NURSERY.

The site for the nursery should be a well drained and protected, though not heavily shaded spot, and of good, heavy, rich soil. The ground should be well broken up the season prior to planting, and the process repeated at the time of planting. The soil for the nursery should be thoroughly pulverized. If the nursery is to be a small one for hand cultivation it may be plotted into compartments for different kinds of seeds and for conducting areas of transplanted trees for larger ornamental plantings. The compartments may be made into raised beds or left at a level, just as the owner determines, and may be made of sizes suited to the cultivation. The rows for hand culture may be made from 18 to 24 or 30 inches wide, though for hoe culture the distances need to be very much less than for horse and plow cultivation. The furrows for the seed may be made with any device that will answer the purpose. The seed in the rows should be planted at a distance of about two inches apart and should be covered with fine soil to a depth of about twice as deep as the seed is thick, and the dirt thoroughly packed upon them. Do not do this when the soil is likely to bake very hard. Broadcast planting may be done instead of rows if desired, though because cultivation can not be given the young trees it is not as successful as the former.

If the nursery is to be of considerable proportions, the rows should be made from three to four feet apart that they may be cultivated with the plow and horse.

For extensive forest planting the seedlings should be transplanted at the end of the second year, and those having grown best may be transplanted at the end of the first year to the forest. By transplanting at these ages all the labor, digging and planting, can be performed at much advantage over larger trees. Trees which are retained in the nursery for larger size to be planted for ornament should be transplanted at least twice at intervals of two or three years. In transplanting the roots will necessarily be pruned, as will also the top, as both should always be kept in proportion, and this will cause a numerous fibrous root formation which insures better success in living when the tree is finally planted to the permanent place.

If the seeds are to be planted directly to the area intended for the forest and in the places where they will be left to grow into trees without transplanting, then the soil must be prepared to receive them.

SOIL PREPARATION.

The preparation of soil for forest planting has been treated under the topic, "Regenerating the Farm Forest," but a better discussion here will not be amiss. Cleared land is prepared for receiving the seeds in just the same manner it is for corn planting. It is well broken, pulverized and marked off into rows either one or both ways, as desired, though it should be marked both ways to admit of cross-cultivation. (The distances apart at which the rows should be made is a matter not yet satisfactorily determined, but the usual distances are from four to six feet.) The seed are then planted in the checks and covered. This may be accomplished in any manner found best and convenient. After planting, the soil should be packed thoroughly by rolling it. Any soil that will admit of this manner of preparation should receive it. If the surface is such that it can not be thus treated, the seeds will have to be planted by any means to get them into the earth and sufficiently covered. A hoe, mattock, dibble, circular spade or pick may be found serviceable means. An apron sack may be made to carry the seeds by the planter.

The number of seeds to plant in a hill will depend on the character of the seed. Fifty per cent. is considered a good average for forest seed germination. If the seeds are carefully selected and stored a larger per cent. may be obtained; but under all conditions two to the hill should be planted, and if they germinate well it is better to have to thin than to replant. A good stand should always be the aim. The thinnings can be used to transplant elsewhere.

It is advisable with certain trees to at all times plant the seed in the place where the tree is to grow permanently, while with others it is better to grow the seedlings in the nursery and transplant, and still others are better grown from cuttings. The trees, the seed of which should always be planted in the permanent place where the tree is to grow, are: Oak, hickory, walnut, chestnut, beech and sugar maple, though they can be transplanted at an early age with a little success. All others can be successfully transplanted from seedlings, especially when young and the conditions are anything like favorable. The poplars, willows and aspens are best grown from cuttings.

FOREST TREE CUTTINGS.

The time to make the cuttings is any time between the sap's going down in the fall and its coming up in the spring. The particularly best time is February and March. The cuttings should be made from one and two-year-old growths of branches and ranging from one-quarter to one-half inch in diameter.

A convenient length for cuttings is eight to twelve inches. The cutting should be done with a fine sharp instrument, so as not to split the wood. The cuttings should be tied in bundles of fifty to one hundred each, the large ends all tending the same way, and the bundles then buried to prevent their drying out. They should be buried at least ten or twelve inches deep, to prevent drying. Freezing will not hurt them.

Cuttings should be set in the spring, and the ground should be prepared same as for seed if can be. They should be set in the permanent places, the same distance apart as when planting the regular forest, four feet apart. They may be set straight or slanting, as is convenient, and the earth firmly packed around them. Not more than two inches of the cutting should be left out of the ground after setting.

They should be cultivated well to keep weeds and grass down and the soil loose for growing. Where the soil can not be well plowed and pulverized a good method to set cuttings is to use a "dibble" in making openings in the ground. This instrument is handy, cheap and the best to use in such cases.

Seedling Transplanting.

The preparation of the soil for planting seedlings is the same in all instances as has been given for seed planting. The making of excavations to receive the trees is the thing most difficult, to not impede rapid progress. If the trees are large and have spreading roots, the places must be made large enough to receive the roots without cramping them. It is better, therefore, to transplant the seedlings at an early age, in order to lessen the work as well as to insure better results of growing. Most seedlings at the ages of one or two years do not possess much root system, simply a straight stem with small hair fibers. If the ground is well prepared the planter can make the holes with a sharpened handspike by jabbing it into the loose soil and prying in all directions. If it can not be performed in this manner a circular spade, dibble or other implement adaptable to make the small holes necessary can be used. If the former plan is followed the planter can quickly make the holes, insert the slender root and firmly press the dirt around it. In all instances the dirt should be pressed thoroughly around the roots so that no air remains around them. To this cause may be attributed the death of many trees planted. In some instances a spade was inserted into the soil and the earth pried apart, the tree root inserted, the spade removed and the earth stamped firmly upon the roots. For planting the small seedlings various methods may be employed to make the excavations successfully.

If larger trees are planted, more work and effort will be required to make the holes and to plant the tree properly.

The digging of the seedlings should be performed in a way not to injure them. In a small nursery, and when the trees are young, a sharp spade can be used by cutting along both sides of the rows and then lifting the trees out carefully. At all times mangling the trees should be avoided. It is not essential to prune unless the trees should become broken, when they should be pruned smoothly.

The trees may be dug in the fall and heeled in over winter for early planting in the spring. Young trees in this climate should not be planted in the fall. The winters are too severe on them in their newly planted condition. The same thing is also true, in my judgment, for larger trees.

The trees can be heeled in in the cellar by keeping moistened dirt over the roots. The usual method of heeling trees is to dig a trench deep enough to bury the roots and the greater part of the bodies of the trees. Extend the trench east and west, the south bank sloping at an angle of about 30 degrees. Place the trees in the trench in single layers with the tops to the south and cover each layer with fresh earth. It is advisable to leave only the branches exposed. They may be left in the trench till they are taken out for planting. Select the site for the trench where the drainage is good.

When removing for planting, the roots should be plunged into a vessel containing a mixture of clay and water formed into a slush. The same thing should be done to the seedlings when taken from the nursery unless they are immediately planted or heeled in. The roots of any tree which it is intended to transplant should never be allowed to become dry.

The distances at which trees should be planted are 4, 5 and 6 feet apart for regular forest plantings, and should be in rows both ways to admit of cross-cultivation. They should be plowed or cultivated in some manner to keep down the weeds till they are large enough to survive by themselves.

The close planting enables them to soon shade the ground and thus conserve the moisture to them. Besides, it aids in natural trimming and long, straight trunk formation. Successive thinnings will be necessary when they begin to crowd and smother out.

The principle of tree growth is that if a tree is grown in the open it branches and forms a shade tree. The growth goes to limbs and branches instead of body formation. If it is crowded, it goes up in search of light, does not branch, and consequently a good trunk is formed to make the tree valuable.

The Forest in the Life of a Nation.

President Theodore Roosevelt opened the public meeting of the American Forest Congress with the following address:

It is a pleasure to greet the members of the American Forest Congress. You have made, by your coming, a meeting which is without parallel in the history of forestry. For the first time the great business and the forest interests of the nation have joined together, through delegates, altogether worthy of the organizations they represent, to consider their individual and their common interest in the forest. This meeting may well be called a congress of forest users, for that you are users of the forest, come together to consider how best to combine use with conservation, is to me full of the most hopeful possible promise for our forests.

The producers, the manufacturers, and the great common carriers of the nation had long failed to realize their true and vital relation to the great forests of the United States, and forests and industries both suffered from that failure. But the time of indifference and misunderstanding has gone by. Your coming is a very great step toward the solution of the forest problem—a problem which can not be settled until it is settled right. And it can not be settled right until the forces which bring that settlement about come, not from the government, not even from the newspapers and from public sentiment in general, but from the active, intelligent and effective interest of the men to whom the forest is important from the business point of view, because they use it and its products; and whose interest is therefore concrete, instead of general and diffuse. I do not in the least underrate the power of an awakened public opinion; but in the final test it will be the attitude of the industries of the country which more than anything else will determine whether or not our forests are to be preserved. This is true because by far the greater part of all our forests must pass into the hands of forest users, whether directly or through the government, which will continue to hold some of them, but only as trustee. The forest is for use, and its users will decide its future.

The great significance of this congress comes from the fact that henceforth the movement for the conservative use of the forest is to come mainly from within, not from without; from the men who are actively interested in the use of the forest in one way or another, even more than from those whose interest is philanthropic and general. The difference means to a large extent the difference between mere agitation and actual execution, between the hope of accomplishment and the thing done. We believe that at last forces have been set in motion which will convert the once distant prospect of the conservation of the forest by wise use into the practical accomplishment of that great end, and of this most hopeful and significant fact the coming together of this congress is the sufficient proof.

The place of the forest in the life of any nation is far too large to be described in the time at my command. This is peculiarly true of its place in the United States. The great industries of agriculture, transportation, mining, grazing, and, of course, lumbering, are each one of them vitally and immediately dependent upon wood, water or grass from the forest. The manufacturing industries, whether or not wood enters directly into their finished product, are scarcely, if at all, less dependent upon the forest than those whose connection with it is obvious and direct. Wood is an indispensable part of the material structure upon which civilization rests, and civilized life makes continually greater demands upon the forest. We use not less wood, but more. For example, although we consume relatively less wood and relatively more steel or brick or cement in certain industries than was once the case, yet in every instance which I recall, while the relative proportion is less the actual increase in the amount of wood used is very great. Thus, the consumption of wood in shipbuilding is far larger than it was before the discovery of the art of building iron ships, because vastly more ships are built. Larger supplies of building lumber are required, directly or indirectly, for use in the construction of the brick and steel and stone structures of great modern cities than were consumed by the comparatively few and comparatively small wooden buildings in the earlier stages of these same cities. Whatever materials may be substituted for wood in certain uses, we may confidently expect that the total demand for wood will not diminish, but steadily increase.

It is a fair question, then, whether the vast demands of the future upon our forests are likely to be met. No man is a true lover of his country whose confidence in its progress and greatness is limited to the period of his own life, and we can not afford for one instant to forget that our country is only at the beginning of its growth. Unless the forests of the United States can be made ready to meet the vast demands which this growth will inevitably bring, commercial disaster is inevitable. The railroads must have ties, and the best opinion of the experts is that no substitute has yet been discovered which will satisfactorily replace the wooden tie. This is largely due to the great and continually increasing speeds at which our trains are run. The miner must have timber or he can not operate his mine, and in very many cases the profit which mining yields is directly proportionate to the cost of the timber supply. The farmer, east and west, must have timber for numberless uses on his farm, and he must be protected, by forest cover upon the head-waters of the streams he uses, against floods in the east and the lack of water for irrigation in the west. The stockman must have fence posts, and very often he must have summer range for his stock in the national forest reserves. In a word, both the production of the great staples upon which our prosperity depends and their movement in commerce throughout the United States are inseparably dependent upon the existence of permanent and suitable supplies from the forests at a reasonable cost.

If the present rate of forest destruction is allowed to continue, a timber famine is obviously inevitable. Fire, wasteful and destructive forms of lumbering, and legitimate use, are together destroying our forest resources far more rapidly than they are being replaced. What such a famine would mean to each of the industries of the United States it is scarcely possible to imagine. And the period of recovery from the injuries which a timber famine would entail would be measured by the slow growth of the trees themselves. Fortunately, the remedy is a simple one, and your presence here is proof that it is being applied. It is the great merit of the Department of Agriculture in its forest work that its efforts have been directed to enlist the sympathy and co-operation of the users of wood, water and grass, and to show that forestry will pay and does pay, rather than to exhaust itself in the futile attempt to introduce conservative methods by any other means.

The department gives advice and assistance, which it will be worth while to know more about, and its policy is one of helpfulness throughout, and never of hostility or coercion toward any legitimate interest whatsoever. In the very nature of things it can make little progress apart from you. Whatever it may be possible for the government to accomplish, its work must ultimately fail unless your interest and support give it permanence and power. It is only as the producing and commercial interests of the country come to realize that they need to have trees growing up in the forest not less than they need the product of the trees cut down, that we may hope to see the permanent prosperity of both safely secured.

This statement is true not only as to forests in private ownership, but as to the national forests as well. Unless the men from the west believe in forest preservation, the western forests can not be preserved. The policy under which the President creates these national forests is a part of the general policy of the administration to give every part of the public lands their highest use. That policy can be given effect in the long run only through the willing assistance of the western people, and that such assistance will be given in full measure there can no longer be any doubt.

I ask, with all the intensity that I am capable of, that the men of the west will remember the sharp distinction I have drawn between the man who skins the land and the man who develops the country. I am going to work with, and only with, the man who developes the country. I am against the land skinner every time. Our policy is consistent to give to every portion of the public domain its highest possible amount of use, and, of course, that can be given only through the hearty co-operation of the western people.

I want to add a word as to the creation of a national forest service, which I have recommended repeatedly in messages to the congress, and especially in the last. I mean the concentration of all the forest work of the government in the Department of Agriculture. As I have had occasion to say over and over again, the policy which this administration is trying to carry out through the creation of such a service is that of making the national forest more actively and more permanently useful to the people of the west, and I am heartily glad to know that western sentiment supports more and more vigorously the policy of setting aside national forests, the policy of creating a national forest service, and especially the policy of increasing the permanent usefulness of these forest lands to all those who come in contact with them. With what is rapidly getting to be the unbroken sentiment of the west behind this forest policy, and with what is rapidly getting to be the unbroken support of the great industries behind the general policy of the conservative use of the forest, we have a right to feel that we have entered on an era of great and lasting progress. Much, very much, yet remains to be done; but the future is bright, and the permanence of our timber supplies is far more nearly assured than at any previous time in our history. To the men whom this congress contains and represents this great result is due.

In closing, I wish to thank you who are here, not merely for what you are doing in this particular movement, but for the fact that you are illustrating what I hope I may call the typically American method of meeting questions of great and vital importance to the nation—the method of seeing whether the individuals particularly concerned can not, by getting together and co-operating with the government, do infinitely more for themselves than it would be possible for any government under the sun to do for them. I believe in the future of this movement, because I think you have the right combination of qualities—the quality of individual initiative, the quality of individual resourcefulness, combined with the quality that enables you to come together for mutual help, and having so come together to work with the government, and I pledge you in the fullest measure the support of the government in what you are doing.

The Forest Policy of France.

Mr. J. J. Jusserand, the French Ambassador, at the public meeting of the American Forest Congress, made an address, from which the following is excerpted:

"The subject of your studies is one, indeed, which appeals most powerfully to man's mind, not to say man's heart. The forest is the great friend which supplied the early wants of mankind, giving the first fuel, helping to rear the first real house. And now, after the lapse of thousands of years, the forest continues the great friend, so adaptable is it to our wants.

"This country is immense, its resources prodigious; the nation is a young one—should not something be allowed to youth? Certainly, anything, except what might maim and cramp a splendid future.

"That something is allowed can not be doubted. One of the first things which struck me, coming over to America, was how much was allowed, especially in the matter of forests. Going north, west or south sights of the same sort met my gaze and my French eyes were opened with surprise. Going to St. Louis last year, I noticed large spaces where big trees had been cut, the stems remaining as high as man's shoulder. So much wood lost, I thought; so much land untillable! Coming from Canada on another occasion, the train was following a succession of what should have been beautiful valleys. But the view was saddened by the corpses of innumerable trees which had been cut, for what cause I do not know—was it for their bark or for something else? I could not surmise; but the fact was that they were there, crumbling to pieces, rotten and unavailable, spoiling the landscape and making the soil useless by their thousands of dead bodies. Going to Louisiana in another case, my heart bled at seeing the blue sky blackened by the smoke of forests in flame. This terrible mode of clearing the ground seems to be still in use, and I noticed places where the fire, being not violent enough, had not cleared the ground, but had ruined and killed the trees, so that it was havoc pure and simple.

"You can afford to spend today. Will you be able to do the same tomorrow? Maybe; maybe not; and squandering habits when once taken are most difficult to check, at a moment's notice, just at the time wanted.

"We know it in France; we have known it for a thousand years (a moderate computation). We have not your boundless resources; we must husband what we possess. Our land is limited, our mines of small importance. Our fields have been furrowed by the plow for eighteen centuries more than yours, the accumulated public debts, left by past regimes or caused by present necessities, weigh on our shoulders, and yet with this weight at this day we stand, and if I may believe what I hear reported, our friendship is still worth having, as well worth it as it was ever in time past.

"There is only one explanation: What we do, we try to do with method; what we do, we do with care. We have no other secret. There is nothing lost in France, nothing thrown away, not a rag, not a bit of bread, not a stick of wood. Many think we are a laughing, singing nation. If we were such and nothing more, we should have long since disappeared. We are a living example that people may love to have their laugh and their song, and yet keep their forests in good order. Method and gloom do not go necessarily together."

The policy of France in the matter of forests, the Ambassador pointed out, is a time-honored one, and the people early were impressed with the necessity of preserving forests. In France there is a national school of forestry, at Nancy, where the sound principles of forestry are taught. The practical importance of this teaching is testified to by many foreign students, of whom some came from America. In this connection he named Mr. Pinchot, the chief of the Forestry Bureau of the Agricultural Department.

The French forests have not only a code, but an army of their own—an army of 6,000 men, foresters, rangers and keepers—a real army, subjected to military discipline, so much so that in time of war this troop is transferred from the Ministry of Agriculture, where all the forestry services are centered, to the Department of War. In 1860 a law was enacted making it obligatory for the owner of mountains or mountain slopes to reforest them if denuded, the government supplying the seeds. In 1882 a law was passed giving more liberty to the landowner. He is allowed to refuse to do the work. The government has then the right to pay him a fair sum for his land, expel him, and plant the trees, so important is it considered for the whole community.

"The importance of such plantations is more and more apparent. We see destruction and poverty invade the parts where they have not been observed; wealth and comfort grow in those where the rules have been observed. Where there is a just proportion of forest ground the temperature is more equal, the yielding of water springs more regular, and observations in the south of France have shown that since the Esterel has been reforested the destruction caused by that terrible wind called the mistral has diminished.

"The sea coasts of France were being gradually invaded by the sand, and the wind carried that death powder farther inland as years passed on. In 1810 we tried forestry and the forest showed itself, as usual, the friend of man; the sand country has entirely disappeared as well on the ocean as on the channel and the desolate regions of yore are now wealthy, pleasant ones, where people even flock for their recreation and their health.

"The same careful and methodical policy is being introduced into our colonial dominions. There the difficulties are sometimes very great, because the havoc has been more complete. We try, for example, to reinduce trees to give back to southern Tunis its pristine fertility. Most of it is now a sand desert. What it was in Roman times we know by the ruins and the inscriptions. The capital of the south, Suffetula, as it was called, consists now of scattered ruins in the midst of absolute desert. One of the inscriptions discovered contains a description given by an old Roman veteran of what his villa was. He had retired there after his campaigns and describes the trees, the plots of grass and the fluent waters which adorned his retreat, now buried under the shroud of the desert sand.

"The Arab conquest destroyed all the trees there and killed the forest; the punishment was not long in following. No forest there? No men. Not long after the conquest the mischief was already considerable, the land was desolate and an Arab chronicler seeing the havoc done recalled in his book the former times of prosperity, adding: 'But in those days one could walk from Tripoli to Tunis in the shade.'

"There are, as you know full well, two great classes of forests, and no more. There is the wild forest and there is the civilized forest. People who know forests only through books, I mean through bad books, not the books written by members of this assembly, fancy that the wild forest is the thing. A time was, too, when people thought that the wild man, the man in the state of nature, was a nest of virtue and that, leading a kind of simple life, he led also, of necessity, a model life. The truth is quite different; virtue, like all plants of price, needs cultivation; forests need the eye, the mind and the heart of man. Instead of being full of the most beautiful and useful trees the wild forest offers a prodigiously small quantity of good trees; many have outlived their period of use and they prevent the growth of others; many have grown crooked; wicked ones have injured the righteous.

"Now the question is, which sort of forest is to be favored here? It is a great thing for this country to know what its intentions are and what you mean to do. In doing it, in fulfilling your duty as good foresters, it so happens that you will at the same time second what is uppermost in the mind of every good American—that is to help, so far as is in you, to the spreading of civilization."

Work of the Pennsylvania Railroad in Planting Timber for Cross-ties.

It has been largely through the instrumentality of the Forestry Association that the railroad companies of the United States have been brought to realize the gravity of the situation with reference to a future timber supply, from which is to be furnished the large quantity consumed by the railroads in the production of cross-ties. The rapid spoliation of our forests—the sole source of our supply—and the imminence of its entire depletion are only too strongly presented to us by those familiar with the subject.

It would take more time than I have at my disposal to obtain statistics to cover the entire field of timber consumption in the United States, or to make any reliable computation of the amount of timber still standing and available for future supply, but a few figures illustrative of the general character may be of interest as an introduction to what more particularly concerns the Pennsylvania Railroad System.

During the past year the Pennsylvania Railroad Company has had the subject considered and a report made by a committee of our transportation association, and I will draw from this report some data for my remarks of today.

The number of cross-ties in use on the railroads of the United States is estimated to be about 620,000,000; the number used annually for repairs and for extensions of track is estimated to be from 90,000,000 to 110,000,000, requiring, we may say, the entire product of 200,000 acres of woodland annually.

Each year the timber from which these are manufactured is farther from the base of transportation, many of the former sources of supply have already been entirely exhausted. Our Pennsylvania railroads now look chiefly to inland Virginia, West Virginia and Kentucky for our white oak ties, and the long leaf yellow pine of the Southern States will soon disappear; probably another decade may nearly close these sources of supply.

The annual consumption of ties on the Pennsylvania Railroad System east of Pittsburg and Erie, for repairs only, is about 3,000,000, the latter being about the average quantity used every year for repairs in the past ten years. To this should be added, say, 500,000 used annually for new work.

It is evident, therefore, that at the present rate of consumption the available supply of the present timbers used, especially white oak and yellow pine, will be exhausted to a serious degree before many years, and the time is now ripe for the railroads to consider the question of what course they are to pursue in the future.

Under these conditions there are obviously two courses:

First. The reduction of the amount consumed, which can be done by the substitution of other material for wood, and by the use of preservative methods for prolonging the life of the ties, and which by increasing its durability will diminish the annual requirements for renewals, and

Second. By the adoption of forestry methods, having for its purposes the proper care and management of the forests still remaining, and the cultivation of new tree plantations.

It is to the latter to which I will chiefly confine my remarks in connection with this all-important subject.

The question of forest preservation and perpetuation is beginning to receive attention in this country through the several State Bureaus of Forestry which have been established, and attention is given to forest preservation by these, as well as by the National Government.

The National Government has established a Department of Agriculture, which is doing valuable work in the dissemination of useful information, and by creating a popular sentiment in favor of the subject, and its co-operation with railroad companies and lumber industries in the introduction of proper methods for the preservation and perpetuation of the timber supply of the country.

The necessity or advisability of a railroad company taking an active part in forestry operations, looking especially toward its future supply of cross-ties for its own use, is comparatively a new idea.

As long as twenty-four or twenty-five years ago, on the Pennsylvania lines west of Pittsburg, attention was already given to the subject, and a number of catalpa trees were planted along the right of way of one of its lines, but the results obtained were unsatisfactory.

More recently, the cultivation of the yellow locust as a tie timber has been brought to our attention, and the cultivation of this tree to a limited extent, for the purposes named, has been undertaken.

Within the past two years we have begun the planting of the yellow locust trees on an extensive scale on property owned by the company. The trees thus planted are seedlings two or three years old, and cost, including labor of planting, about 8 cents each.

Generally speaking, these are planted 10 feet apart, thus averaging about 400 to the acre, although in the fall of 1904 we planted 54,871 trees 6 feet apart, and 88,127 trees 8 feet apart.

The total quantity planted to date is as follows:

Fall of 1902 at	
Newton Hamilton	13,610
Fall of 1903 at	
Conewago	43,364
Spring of 1904 at	
Conewago	25,096
Pomeroy	20,280
West of Atglen	16,537
Atglen	8,108
Fall of 1904 at	
Juniata Bridge	20,730
Newport	29,505
Vintage	50,300
Atglen & Susquehanna Branch P. R. R.	53,000
Total	280,530

All of these places are in the State of Pennsylvania.

During the coming year we expect to plant about 800,000 trees additional, say 200,000 in the spring and 600,000 in the fall.

The land on which we planted these, except a tract of 14 acres at Newton Hamilton, which was purchased for this particular purpose, are lands which the company has owned for some time, and which were acquired in connection with old or new lines.

There is probably no other timber which combines so well the qualities of durability and hardness as does the yellow locust. Evidences of their longevity in use as tie timber are frequent on our road.

The resistance of locust timber to cutting under the rail is said to exceed that of white oak, and it has been demonstrated upon our main lines that it is not so much the decay of the timber as it is the cutting in by the rail, which wears out, or decreases the life of, the tie. The average life of a white oak tie is about ten years—we expect to get additional life out of a locust.

The main attention which this class of timber seems to require during growth is that of pruning the lower branches of the young trees, ploughing and harrowing the ground in which they are planted, and keeping the weeds down as far as possible.

Whilst it is not likely that the railroad company will at any time undertake to plant a sufficient number of trees from which to secure its entire supply of cross-ties, we feel that the experiment made by the railroad, of raising its own tie timber, will have a tendency to stimulate outside parties, who are small owners of property, to cultivate this class of timber, and in this way assist the railroad company, in the vicinity in which they are located, by furnishing cross-ties at some future time.

In order to supply our entire needs for the year, namely 3,000,000 for repair and 500,000 for new work, and adding thereto 10 per cent. for the immediate future increase, making the total annual requirements 3,850,000 ties, we figure that 3 ties to a tree would require about 1,300,000 trees each year to produce the 3,850,000 ties (figuring that it will require thirty years for a yellow locust to mature), would require a continuous growth of 39,000,000 trees, 1,300,000 to be planted each year, which, if planted each year, and if planted 10 feet apart, or about 400 trees to the acre, would entail the continuous use of 97,500 acres, or 152 square miles of ground for the purpose.

The Relation of Forest Reserves to the Mining Industry.

BY MAJOR F. A. FENN,

Superintendent of Forest Reserves in Idaho and the Gallatin Reserve in Montana.

Ever since the metalliferous mining first became an important industry in the United States the Government has dealt with it in the most liberal manner. The steadfast policy has been to stimulate the prospecting of the country and encourage the development of its mineral resources. Whatever tends to retard the progress of the miner's work contravenes that policy, anything calculated to advance his interest accords with it.

Congress in the enactment of the law authorizing the setting apart of portions of the public domain as forest reserves consistently adheres to its course respecting mining when it provided in that act as follows:

"It is not the purpose or intent of these provisions, or of the act providing for such reservations, to authorize the inclusion therein of lands more valuable for mineral therein, * * * than for forest purposes."

And further: "Nor shall anything herein prohibit any person from entering upon such forest reservations for all proper and lawful purposes, including that of prospecting, locating, and developing the mineral resources thereof: Provided, that such persons comply with the rules and regulations covering such forest reservations."

And further still: "And any mineral lands in any forest reservation which have been or which may be shown to be such, and subject to entry under the existing mining laws of the United States and the rules and regulations applying thereto, shall continue to be subject to such location and entry, notwithstanding any provisions herein contained."

While the act contains the above quoted provisions, it also outlines a plan for the preservation of the forests within the reserves and gives to the Secretary of the Interior power to elaborate the system and make it effective (by authorizing him to "make such rules and regulations and establish such service as will insure the objects of such reservation, namely, to regulate their occupancy and use and to preserve the forests thereon from destruction."

Realizing the vital importance of the mining industry to the national prosperity and at the same time appreciating the necessity of protecting the forests for the benefit of the people, the law-makers devised a scheme of forest protection that enables forest reserves to be maintained and the mining industry to be carried on simultaneously in the same territory, not only without conflict or friction but in such manner that scientific forest methods may be applied in fullest measure while the best interests of the bona fide miner are subserved and promoted.

Strange as it may seem, after knowing the provisions of the law cited above, the establishment of a forest reserve in a mining region often excites grave apprehension in the minds of the residents of the locality. Fearing dire results from the presence of the reserve, with the administration of which they are unfamiliar and the effects of which they have not studied, mine owners are frequently aroused to strenuous opposition and seek in every way to escape from imaginary ills. What they would avoid they find in the end to be a beneficent boon.

An apt illustration is found in the history of the Black Hills Forest Reserve, one of the earliest to be set aside. The great Homestake Mine is within the limits of that reservation and when it was created the Homestake people were panic stricken. They thought the innovation would at once close their mine, and they believed its continuance would result in the practical destruction of their property. They sought to have the reserve abolished and they fought it tooth and nail. The Government was firm, however, and insisted on conferring its benefits. The experience of years has shown the Homestake owners their error. Now they appreciate the reserve system and are working hand in hand with forest officers in all that concerns the reserve. Not only so—they have adopted reserve methods in the management of their own extensive timber holdings. Now they regret that the reserve was not created before the mine was discovered.

The forest reserve system contemplates the accomplishment of a two-fold object in the preservation of the forests; first, to keep them in the state of highest continued production for the benefit of the people locally dependent upon them for a supply of timber products; and, second, to conserve the water supply and maintain an equal flow in the streams. These two chief purposes are admirably suited to meet the needs of the two great branches of the mining industry, lode mining and placer mining. The principal natural product required by the lode miner is timber, while the placer miner is powerless to carry on his operations without water.

Man is ever extravagant with whatever nature bestows, and miners in the use of timber, if unrestrained, demonstrate the rule. Their business makes them creatures of the present. They rarely consider the ultimate good of the community when they are cutting timber; they regard only the satisfaction of their own immediate needs in their quest for wealth. Commonly in the mountainous mineral districts there is naturally a goodly supply of timber, but the discovery of mines leads quickly to the reckless destruction of this and to the heedless impairment of the forest growth. No thought is given to the future. Wasteful, careless methods of cutting prevail and vast accumulations of tops, limbs, and other refuse soon encumber the cut-over tracts. Fires now get in and what may have escaped the ruthless hand of the chopper falls a prey to the devouring flames. Were the fire confined to the areas cut over, the damage would not be so great, but, unopposed, it sweeps on, urged by the applauding winds, and the demon of destruction works its will. Thus are destroyed quantities of timber, compared with which the amount consumed by man is insignificant. The fire is the great and real destroyer, but man, unintentionally, is, too often, responsible for the conditions which make the awful destruction possible.

Worse yet and wholly inexcusable, is the damage done by the fire-bug, who, in order to clear a brushy hillside or remove thick timber in a canyon, deliberately sets fire to the country to facilitate prospecting work. Thousands of acres of most valuable timber have been burned in this way, to the inestimable damage of the mining industry. The anxious but unprincipled seeker for a mine lets selfishness blind him to the best interests of the community. For a temporary personal convenience he does that which may render his mine, if he find one, practically valueless, because he destroys the supply of timber upon which, very likely, hinges the question whether or not the property may be profitably worked. Such a person is unworthy the name of a prospector; he is a disgrace to the honorable class of men, among whom he intrudes himself. No penalty too severe can be imposed upon such malicious miscreants.

In the vicinity of almost every mining camp the naked hillsides testify to the fearful destruction wrought in the early days. Where formerly the mountains were covered with forests, they are now denuded. Favored spots may be seen, whereon a limited growth of seedlings and saplings proves nature's efforts to restore normal conditions, but many years must elapse ere her object can be attained, even with all the care and assistance forest reserve methods may render. In the meantime, the mines near by must, at great cost, draw upon distant sources of supply for such timber as is necessary to their continued operation.

It would appear idle to furnish examples, but an illustration is found near Virginia City, Mont., towards the head of Alder Gulch, once famous as the richest placer mining camp of the time. Producing mines are in active operation there, and development is progressing in many lode claims. But there is a shortage of forest products. Wood for fuel can not be gathered in quantities sufficient to meet the actual demand for more than a year or so longer, while timber for underground work must be hauled long distances, and even then the material is very inferior. The stand of the scrubby timber now being utilized at great cost will be wholly inadequate unless the most rigid economy be exercised in the use of the limited supply at present available. Electricity generated by water power at remote points must supplant steam as motive power, and every device for restricting the use of timber about the mines must be resorted to or a permanent shut-down on account of lack of timber will result. And this economical use must be supplemented, too, by the most careful protection and husbanding of the young growth now struggling for a start on the cut-over and fire-swept areas. There will be a large amount of small stuff suitable for lagging and similar material on these tracts within a comparatively short time, but if cutting and culling be allowed to be done without restriction or proper supervision, what now promises to be a fairly good timber supply will be utterly destroyed before the day of its real utility arrives. Originally there was an abundance of good timber in that locality, and had forestry methods prevailed there during the forty years of the camp's existence, there would be enough yet for all legitimate needs and the miners would not be threatened with a timber famine.

The quartz-mining region around Silver City and Le Lamar in Idaho affords another case to illustrate the injurious effects of thoughtless extravagance in the use of timber in the pioneer days. Had the timber which nature placed there been economically used and care taken to prevent fires while the renewal of the forests was in progress, there would have been no shortage, but, as things are, coal must be used for fuel for domestic purposes, power for the mines is derived from the large electric plants at Swan Falls of the Snake River that cost over $3,000,000, and timber for underground use must be transported to the mines by rail and wagon from the forested areas of central Idaho and Oregon.

Everyone familiar with placer work in any long established camp has heard the general complaint, "The climate must be changing, for water gets scarcer and scarcer every year." Streams which formerly furnished ample water for the working of extensive properties during the full open season a few years ago are now without a sufficient flow for more than a few weeks' run in the claims. The unoffending climate is held responsible for all this. We might paraphrase and say, "Oh! Climate, what sins are committed in thy name!"

The true reason for the unfortunately changed situation is not far to seek. The mountain slopes once forest, now denuded, tell the tale of repeated fires and the consequent reduced water-storing capacity of the country drained by the streams from which the placer miner's ditches used to be so well supplied.

These deplorable conditions, menacing as they are to the prosperity of every quartz and placer miner, prove the importance, aye, the absolute necessity, of preserving the forests if mining is to continue to hold its exalted place among our industrial pursuits.

Protection from fire is the great essential in forest reserve work at the present time, but there are other matters connected with the preservation of the forests almost equal in importance; timber should be economically used to avoid depleting the supply unnecessarily, and where cutting is done it should be so conducted and the refuse resulting should be so disposed of, as to do the least injury to the remaining forest growth and to leave the cut-over tract in such condition that another crop for the use of consumers yet to be shall be assured. The entire population is interested in these vital questions, but "whatever is everybody's business is nobody's business," and so long as the public generally is responsible for the protection of the forests, just so long will they be without an efficient shielding hand and left to the ravages of fires and wanton despoilers.

The proper safeguarding of the forests requires that the duty be performed by persons specially designated for the purpose. This is sought to be accomplished through the maintenance of a corps of forest officers to whom is intrusted the execution of the law and the rules and regulations governing forest reserves. The forest reserve system in the United States was inaugurated but a few years ago; it is yet in the formative stage, but already its beneficent purposes are recognized and the wisdom of its founders is proven beyond controversy. The system in providing for the creation of forest reserves does not contemplate the locking up of the timber from the people; on the contrary, the forests in the reserves are at all times open for the satisfying of the legitimate needs of the public. Instead of withholding timber from use the true forester encourages the removal of all mature stuff and dead material not only to meet the present needs of consumers, but to make room for and stimulate the young growth and thereby assure a supply for the future.

Timber may be secured from forest reserves in two ways; by purchase, if it be wanted for corporate use or for speculative purposes, and under what is known as the "free use privilege," if it be required by an individual for his personal use. Any person may get whatever timber he requires to satisfy his personal needs free of charge. Thus the prospector or individual miner may obtain whatever he needs for the construction of his cabins, for domestic use, or for the development of his mining property, entirely without cost. But, as any other conservative yet liberal owner of timber would do under like circumstances, the Government will insist that whoever wants timber must ask for it, that he take no more than he needs, that cutting be so done that the least damage shall be inflicted on the remaining timber, and that the refuse resulting from his work be so disposed of that its agents, the forest officers, can burn the same at the proper season and reduce to a minimum the danger from the spread of fires. Certainly these requirements are so reasonable that no sane man can object to them. And then, too, the procedure is simple. Application for what is wanted is made to the nearest forest officer, who, with the applicant, goes to the locality where the timber is found and marks out what is to be cut. Permit to cut is thereupon issued by the proper authority and the applicant cuts and removes his timber and piles up ready for burning the refuse resulting from his work. For large quantities of timber wanted under the free use privilege, the Secretary of the Interior issues the permit, but for amounts where the stumpage value is $20 or less, the supervisor of the reserve issues the permit. It must not be inferred that the fixing of a stumpage value for timber cut under the free use privilege implies any cost or expense whatever to the consumer. The applicant gets what he asks for without a cent of expense in any way or form. The valuation is merely for the convenience of forest officers in determining the value of timber taken by the people under this "free use privilege." It will thus be seen that the Government has most scrupulously guarded the interests of the individual, the prospector or other poor man, who is struggling to maintain himself. But the "free use privilege" is restricted to individuals; if timber is needed by a corporation it must be purchased. Congress in the enactment of the forest reserve law very wisely and very justly held the view that, while the individual striving to improve and develop his claim or other property is entitled to every encouragement, the aggregations of capital represented by corporations are able to pay for what they need in their enterprises. And again, too, if timber is wanted for speculative purposes, for sale to third parties, as for instance, if it is desired by a saw mill operator, it must be purchased.

In sales of timber from a forest reserve the requirements relative to cutting and disposing of refuse are similar to those in "free use" cases, but the price to be paid is determined by forest officers and depends upon the situation, condition, and character of the timber the same as in sales made by one private person to another. Application for sale may be made by any one at any time. The amount that may be purchased is only limited by the amount available in the reserve, keeping in mind danger of impairing its capacity to subserve the great purposes for which it was established.

Foreseeing the necessity of having all undertakings within forest reserves carried on in such manner that they should not defeat the very purposes of the law, Congress gave the Secretary of the Interior power to regulate the occupancy and use of reserves. Whenever the construction of a road, a telephone line, or a ditch, or anything of the kind is desired, or if it be the wish of any one to start a store or other business establishment, the Secretary requires that proper application for the privilege be presented and proper permit therefor be granted before the thing asked for may be done. There is no cost or expense involved; all is free to the applicant. The regulation is imposed to prevent the existence in the reserves of what might be most highly detrimental to them. Without such supervisory control, the forest reserves would be only a name, their administration a laughing stock, and the law a nullity.

It is often objected that the methods prescribed relative to securing timber or obtaining a permit for a special privilege are cumbersome and involve unnecessary inconvenience and delay; in other words, that there is so much "red tape" in the forest reserve business that consumers are practically denied the benefits which Congress intended should be enjoyed under the reserve system. The objection is more specious than sound. Whenever it is the purpose to run a tunnel or sink a shaft for development, or to extend the workings of a property in extracting ore, it is known beforehand that timber will be needed for such underground work; if the construction of a mill is contemplated, the first thing to look for is suitable material; if a steam power plant is to be operated, above all fuel must be provided. This timber question in all such matters is fundamental and should, it would seem, receive primary consideration. The prudent manager of a mine in a forest reserve would, therefore, make provision for timber at the very beginning of his preparation for any such proposed undertaking, by submitting proper application for the amount which he estimates will be required to serve his ends. And the same for any special privilege. Let the application be made for what it is expected will be wanted, at the very inception of the enterprise. An application costs nothing, neither does it bind the applicant to take what is asked for; it is merely a preparatory, often a precautionary step, and if ultimately it be found necessary to abandon the plan, if circumstances make it needless to secure the timber or to obtain the privilege, no harm has been done by the application and the negotiations initiated by it may be suspended or finally dropped. If, on the other hand, what was applied for should be really needed, the timely application prepares the way for the utilization of that which was asked for at the appointed time and place. Experience has demonstrated that the exercise of common business forethought will enable all parties in a forest reserve to get what they are legitimately entitled to receive before the time for its use is reached. There need be no delay or inconvenience on account of reserve regulations.

Miners are more prone to be careless in respect of these matters than most other people, and consequently from them come the bitterest criticisms when they are first brought in contact with the regulations. The explanation is simple. For fifty years the miners of the west have followed the suggestions of their will; they have cut and slashed the forests unrestrained; they have taken without let and destroyed without hindrance. Unfamiliar with the new order of things, they look upon the country which their energy and fortitude reclaimed, as their own by right of discovery and exploration, and they very naturally regard any limitation of the privilege of cutting timber or doing anything else as they please, when they please, and where they please, as an infringement of an inalienable right, and they resent it accordingly. That such position, while natural under the circumstances, is a mistaken one is apparent to any right thinking person, and none is quicker to realize his error than the bona fide miner himself. When once he appreciates what the innovation is intended to accomplish, he promptly adapts his affairs to the new regime without damage or serious inconvenience to himself or his interests. The honest miner who in good faith is developing or working his property encounters no real difficulty when he confronts the forest reserve law and regulations; but it is the stake locator and the person who seeks fraudulently to secure a body of timber under a pretended mining location, that meet with insuperable obstacles to the attainment of their unworthy objects. What mine owner when looking for timber in the vicinity of his claim has not found the best and most accessible supply covered by invalid locations made by some unscrupulous grafter for no other purpose than to "hold up" the legitimate miner and compel him to purchase a worthless claim in order to secure timber to which he is lawfully entitled without money and without price. These hold-up schemes are common, but almost daily in the forest reserves they are being thwarted by the watchfulness and zeal of forest officers and timber involved in them made available for use by those actually needing it for legitimate purposes. Nothing is more detrimental to the true miner's best interests than speculative locations. At the first indication of a prospector's having made a valuable discovery, every inch of surrounding ground, every mill site in the vicinity, every foot of desirable dump ground, every acre of timber for miles around, is seized and staked off by the speculator, the kid glove prospector, for the purpose of blackmailing the man whom the Government wishes to encourage, the man who by his labor and skill is honestly striving to advance the country's welfare.

While reserve officers are protecting the forests from damage by fire and from spoliation, they are at the same time vigilant to guard the Government against fraud in the legitimate location, occupancy and use of pretended claims by persons who from selfish and sinister motives attempt to evade the law relative to the acquisition of title to mineral land. The prospector or miner who in good faith is pursuing his vocation receives every assistance and encouragement from forest officers; they facilitate his operations and while doing so fight off the vampires that would bleed him to death.

Where a forest reserve is established in a mining locality, as soon as the novelty of the situation wears away and the reserve law and regulations are fairly understood, opposition on the part of the law-abiding, law-loving elements of the population ceases and amicable concert of action for the common good is established and harmoniously maintained. The rogue, however, finds his nefarious schemes balked and he is loud in denunciation of the forest reserve system and its officers. It is aptly written:

"No thief ere felt the halter draw
With good opinion of the law."

The honest prospector and the bona fide miner have nothing to fear from a forest reserve. It is established for the advancement of their interests, together with the promotion of the general welfare. Examined comprehensively, the relation of forest reserves to the mining industry appears so intimate, the success of the one so directly interwoven with the continued prosperity of the other, that the possibility of a real antagonism between them can not be entertained. The forest reserve system has come as a permanent benefactor of the mining industry and there is every incentive for miners to give it their loyal support. Forest officers in the administration of reserves will labor for the common good of all, and reciprocally, miners, as active and efficient friends, may cooperate in the achievement of the noble objects alike beneficial to themselves and conducive to the public weal.

Influence of Tree Planting Upon the Duty of Water in Irrigation.

BY F. H. KING,
Professor, University of Wisconsin.

In the effort to discover and establish underlying principles of agricultural science and to direct agricultural practice along lines which shall be in harmony with them, thus leading more directly and certainly to higher economic returns, we stand greatly in need of an increasing body of accurately determined fundamental facts; and it is very much to be hoped that it will be more and more recognized that the development of these fields falls properly within the purpose of Government aid and work. An adequate discussion of the broad problem of how to secure the maximum duty of water in agriculture is not at present possible on account of lack of a sufficient body of well established facts; and this is especially true of that phase of the problem relating to the influence of tree planting upon the duty of water. The body of accurately determined facts regarding the influence of wind-breaks of any type upon the wind movement close to the surface, and especially upon the rate of evaporation from foliage, soil, and water surfaces, is extremely small, and yet such knowledge is necessary to a proper treatment of the subject. Some general facts and tendencies have been ascertained which are helpful for a preliminary consideration of this subject.

INFLUENCE OF WIND-BREAKS UPON VEGETATION.

There is no doubt but that under certain critical conditions wind-breaks do exert a very measurable influence upon vegetation. In the spring of 1894 (Bulletin 42, Wis. Agri. Exp. Stations) during May and June, an opportunity was afforded to make a somewhat critical study of this subject under field conditions. There is in Wisconsin an area of some ten thousand square miles of light sandy soil or sandy loam, and upon the lighter and more sandy portions of these soils crops are occasionally very seriously damaged by the drying effect of the wind; and the fertility of the soil is much reduced by the drifting which occurs at such times. At the time in question, there had been a heavy fall of rain on the 5th and 6th of May, but on the 7th it was clear and cold with a strong wind blowing from the northwest. During this and the following days, notwithstanding the rain, the soils on many fields about Plainfield and Almond, Wis., had been badly drifted. On the morning of the 8th the drifting had gone so far, on many fields, that at both places, the loose sand with which oats had been covered, whether with seeder or with drill, had been driven from the fields to such an extent as to leave the kernels entirely exposed and the plants lying flat upon the ground hanging by the roots and whipping in the wind. On the fields where the whipping had not been so severe and where oats stood three inches high, the oats had been cured like hay close to the ground, and even the leaves of dock sorrel were blackened and so dry as to crumble in the hand. Very many of the blades of oats, through wilting, had broken over close to the ground, presenting an appearance which suggested to the farmers that they had been cut by hand. It was at once evident, to the most casual observer of the fields at this time, that wherever a field lay to the leeward of any sort of shelter the destructive effects of the wind were either not apparent or else they had not been nearly so severe.

About three weeks after the first serious injuries had occurred a careful study was made of many fields and the results are recorded in detail in the bulletin to which reference has been made. Some of the observations made at this time are cited here in illustration of the decisive evidence regarding the influence of wind-breaks upon vegetation. A north and south road two rods wide fenced with wire, along which are scattering trees 10 to 18 feet high, together with a scanty growth of hazel, had a field of oats lying to the east which was greatly damaged; but a strip two rods wide, next to the road, appeared wholly uninjured. A field of oats lying to the east of a field of timothy, in which there was a strong growth of dock sorrel, had a strip of oats 200 feet wide next to the grass where the stand was good, while on the eastern half, thirty rods wide, the plants were entirely destroyed. Another oat field having grass on the north and west sides, and bordered by a rail fence, showed a strip of uninjured grain 100 feet wide next to the two fences and fully 200 feet wide in the northwest corner of the field in the lee of the two fences. In another oat field fully five-eighths of it had been so thoroughly destroyed by the wind that it was harrowed and fitted for potatoes, but a strip along the rail fence on the south side, 150 feet wide, had been allowed to remain on account of the better stand, and on this area, as was usual generally, the number of plants increased as the fence was approached. To the west of this same field there was another of timothy, and adjacent to this there was a strip of oats 200 feet wide where the stand of plants was markedly better than farther away; and the same fact was observed in an adjacent field lying to the east of a closely fed pasture free from trees and shrubs. In another field 120 rods long

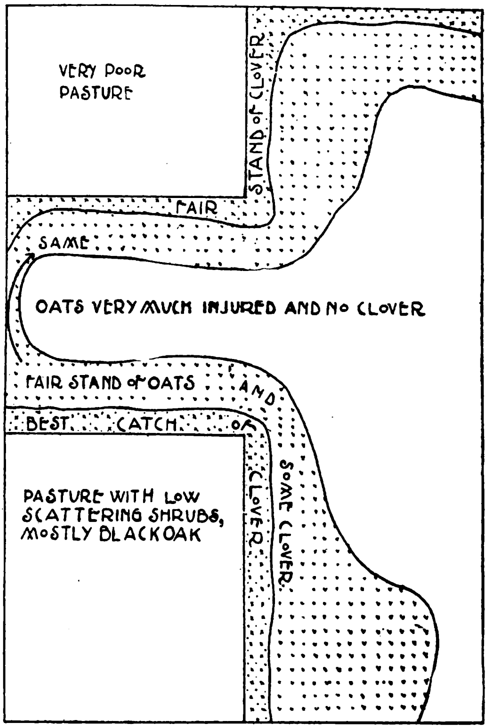


Fig. 1. Showing protected areas of oats and clover in the lee of woods and pasture.

from north to south and 80 rods wide, seeded to oats and clover, the effect of the surroundings upon the crops is indicated in Fig. 1, where it will be seen that at a certain distance from the conditions which have influenced the temperature, humidity, and velocity of the wind, the oats had been very much injured and the clover had been entirely killed out.

In Figs. 2 and 3 the condition of crops which were observed on other fields, and the surroundings which produced these differences, are also shown.

In Fig. 2 the southeastern field is 80 rods long and 30 rods wide. Here it will be seen the oats were good along the road in the lee of the two fences, 40 per cent. gone further away, and entirely destroyed on the eastern half. Further north the field of oats adjacent to the field of grass and with woods to the north and in the distance to the west, had a good stand of plants, being seriously injured only at the south, where the wind came through between the two pieces of woods along the course indicated by the arrow. Similarly, in Fig. 3, the influence of shelters is clearly and sharply brought about by the condition of the crops observed and there recorded. The southern field in this figure was 60 rods from east to west and 30 rods wide. It will be seen that the half of the field stretching out into the path of the free wind coming through the gap between the two pieces of woods, as indicated by the arrow, has lost all of the crop, while the stand increased toward the woods on the west and was good at a distance of 10 to 20 rods from them.

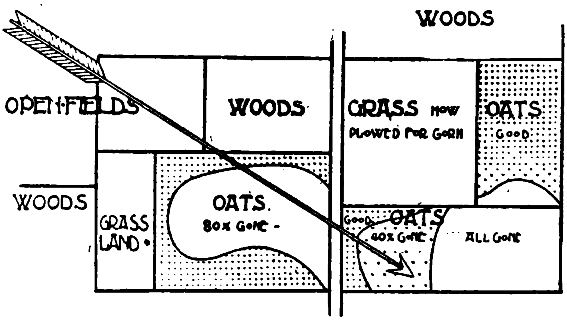


Fig. 2. Showing three fields and surroundings where oats had been entirely killed, together with areas protected from the wind.

The piece of oats lying on the south side of the scantily wooded pasture was in excellent condition, and although only 15 rods wide, a very appreciable difference could be seen in the stand of clover, to which the field had been seeded, on the margin most distant from the pasture. Even fields of corn stubble having fields of oats to their leeward were observed, in three instances, to have exerted very marked effects upon the stand of grain, and in one of these fields, on one portion of the protecting corn stubble, there was a strong growth of dock sorrel. To the leeward of this part of the field the oats had been much less injured, suggesting that the effect of the humidity of the air passing across this may have been enough altered to render the wind current appreciably less destructive. Observations like these appear to place beyond doubt that, under certain conditions, at least, wind-breaks do exert a very measurable effect upon the vegetation of cultivated fields.

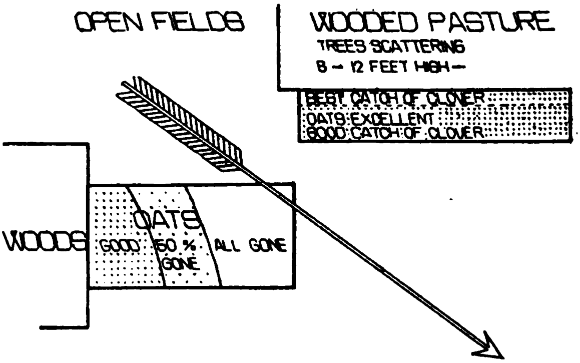


Fig. 3. Showing protection afforded to grain by woods and direction of destructive winds.

On three other oat fields which had been seeded to clover and which were bordered on the west with fields of grass, the number of clover plants upon unit areas which had survived the effect of the wind was determined at different distances from and to the leeward of the fields of grass. The counts were made in series along east and west lines at right angles to the margins of the grass fields, and the results are given in the following table.

TABLE

Showing the Decrease in the Number of Young Clover Plants Per Unit Area With Increase of Distance to the Leeward of the Margin of Grass Land.

Distance from margin of grass. Feet.	No. of Plants. Series 1.	No. of Plants. Series 2.	No. of Plants. Series 3.	No. of Plants. Total.
		Field No. 1.		
50	187	209	187	574
200	120	139	131	390
400	88	75	68	231
		Field No. 2.		
100	77	73	99	249
200	55	109	113	277
400	43	78	72	193
600	67	66	56	189
800	54	54	30	138
1000	27	11	10	48
		Field No. 3.		
50	377	382	371	1130
400	166	209	225	600
700	203	180	160	543

These three sets of data appear to leave little room to doubt that, in some manner, the grass fields to the windward of the fields seeded to clover did exert an influence which materially affected the stand of clover on them. In what manner this effect may have resulted will be referred to later.

INFLUENCE OF WOODS UPON THE RATE OF EVAPORATION TO THE LEEWARD.

At the time of the observations just described, others were made to measure the rate of evaporation at different distances to the leeward of woods, using a form of Piche evaporometer rendered more sensitive by increasing the diameter of the evaporating surface to 5.9 inches, thus giving an effective area of 27.06 sq. in., deducting the area of the water reservoir, the latter being regulated to .1 c. c. The instrument as placed in the field is represented in Fig. 4.

Fig. 4.—Showing the form of Piche evaporometer as placed in the field.

With a series of 6 of these instruments set up in a line at right angles to the margin of a black oak grove having a mean height of 12 to 15 feet, the rate of evaporation which occurred simultaneously between 11:30 and 12:30 a. m. was measured, with the results given in the next table.

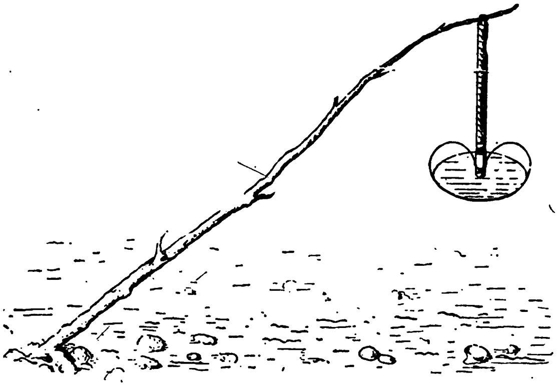


Fig. 4. Showing the form of Piche evaporometer, as placed in the field.

TABLE.

Evaporation One Foot Above the Surface at Different Distances to the Leeward of a Grove of Black Oak in a Field of Sandy Soil Recently Planted to Corn.

Distance from Woods—Feet.	Evaporation in One Hour—C. C.
20	11.0
40	11.1
60	11.3
80	11.2
100	11.9
120	12.9

These results show that until a distance greater than 100 feet is reached but little difference in the rate of evaporation was found. At 120 feet the evaporation was 17 per cent. greater than at 20 feet. Three of the instruments were next set up at 20, 40 and 60 feet, and at 280, 300, and 320 feet from the same grove and in the same field. During one hour the amounts of evaporation were as given in the next table.

TABLE.

Evaporation at One Foot Above the Surface at 20, 40, 60, and at 280, 300, and 320 Feet to the Leeward of a Black Oak Grove in a Field of Sandy Soil Recently Planted to Corn.

Distance from Woods. Feet.	Evaporation in One Hour. C. C.	Distance from Woods. Feet.	Evaporation in One Hour. C. C.
20	11.5	280	14.5
40	11.6	300	14.2
60	11.9	320	14.7
Avrg. 40	11.66	300	14.4

From this table it is seen that the rate of evaporation was 23.4 per cent. greater at 300 feet than at 40 feet, basing the computation upon the averages.

In another locality the evaporometers were set up at distances ranging from 20 to 500 feet to the leeward of a piece of black oak woods where they had an average height ranging between 15 and 25 feet and were thicker on the ground. The results secured during an hour of sunshine in the middle of the day are given in the table which follows:

TABLE.

Evaporation One Foot Above the Surface of Ground in a Field of Oats at Different Distances to the Leeward of a Black Oak Grove of Trees 15 to 25 Feet High.

Distance from Woods—Feet.	Evaporation in One Hour—C. C.
20	11.1
100	14.3
200	15.7
300	18.5
500	18.3

In this series the evaporation appears to have become constant at about 300 feet from the woods and was some 66 per cent. greater than at 20 feet distant.

The effect of a scanty hedgerow was also measured. This was composed of a strip of blue grass 16 feet wide in which there were scattered black and burr oak from 6 to 8, and occasionally 12, feet high. The hedge had open gaps in it and the nearest evaporometer was set up in the lee of a clump of 6 trees spanning a length of 40 feet, there being a gap of nearly equal length on either side. To the windward of this hedge there was a naked field 80 rods wide recently plowed and being planted to potatoes, and the instruments hung above the field of oats where the plants were about 4 inches high. The next table gives the results obtained.

TABLE.

Evaporation One Foot Above the Surface of a Field of Oats at Different Distances to the Leeward of a Scanty Hedgerow.

Distance from Hedgerow—Feet.	Evaporation in One Hour—C. C.
20	10.3
150	12.5
300	13.4

In this case the evaporation at 300 feet from the hedgerow was 30 per cent. greater than at 20 feet, and 7.2 per cent. greater than at 150 feet, and the results make it clear that even scanty hedgerows exert a measurable influence upon the rate of evaporation at considerable distances to the leeward.

INFLUENCE OF A CLOVER FIELD UPON THE RATE OF EVAPORATION TO THE LEEWARD.

Adjacent to the naked field behind the hedgerow just considered, there was a field of clover 360 feet wide along the margin of the oats and extending 780 feet back from it, across which the wind passed in its course from the north. At the same time the last observations were made a similar series was taken to the leeward of the clover, the results being those given in the following table:

TABLE.

Evaporation One Foot Above the Surface of an Oat Field at Different Distances to the Leeward of a Field of Clover.

Distance from Clover Field—Feet.	Evaporation in One Hour—C. C.
20	9.3
150	12.1
300	13.0

These results indicate that at 300 feet to the leeward of the clover the rate of evaporation exceeded that at 20 feet 39 per cent. and that at 150 feet 7.4 per cent. Comparing the evaporation from the two adjacent areas where, as stated, the evaporometers were similarly and simultaneously exposed, it is seen that the air coming across the long stretch of naked ground and then passing through the hedgerow, caused measurably more evaporation than did the current which had traversed the field of clover; and these results appear to be in complete accord with the observations cited regarding the stands of grain and clover to the leeward of woods, hedgerows, grass fields and shelters of other kinds.

INFLUENCE OF WOODS AND GRASS FIELDS UPON THE HUMIDITY OF THE AIR TO THE LEEWARD OF THEM.

At the same time that the several sets of observations were taken and at the same places, others were also made with wet and dry bulb thermometers of the Henry J. Green make, reading to tenth of a degree C. The results obtained are given in the following table, each value being a mean of 10 readings, which were made in regular rotation, passing from station to station of each series during the intervals of exposure of the evaporometers.

TABLE.

Relative Humidity of Air Three Feet Above the Surface at Different Distances to the Leeward of Woods, Hedgerows, Clover Fields and Naked Soil.

Distance to the Leeward. Feet.	Mean Dry Bulb Readings. Degree F.	Mean Wet Bulb Readings. Degree F.	Mean Relative Humidity. Per Cent.
	Grove No. 1.		
30	65.32	49.46	27.0
300	63.80	47.35	24.0
	Grove No. 2.		
20	75.04	58.35	34.6
100	73.13	56.39	33.0
200	72.03	55.83	34.2
300	71.47	55.13	32.8
400	73.63	55.63	29.6
500	73.31	55.94	30.8
	On Leeward Margin of Clover Field.		
0	52.48	43.97	48.0
	On Leeward Margin of Naked Field.		
0	53.24	43.57	44.0

These four series of observations, although too limited to serve as the basis of general conclusions, are, in a general way, quite in accord with the records of evaporation which have been cited, and also in harmony with the very pronounced observed protection afforded to oats and clover to the leeward of the various shelter conditions which have been cited. To my own mind, however, the surprise lies in finding such profound differences in crop conditions associated with the observed differences in meteorological and surface conditions. It should be borne in mind, however, in considering these relations, that the meteorological observations were not made at the time the destructive work was going on; hence what differences then existed are not known. The relations which have been observed and pointed out are clearly vital to the reclamation problems of the arid and semi-arid West, and merit full investigation, especially from the standpoint of field conditions.

The very marked influence which has been observed upon the stand of both oats and clover under the conditions cited is undoubtedly, in large measure, due to the character of the soil and to the stage of growth of the crops, the wind coming at a time when the root system of the plants was yet scantily developed and very close to the surface; but the measurable differences in the stand of clover, at such long distances from the conditions which have evidently produced them, leaves little reason to doubt that crops are sensitive to such differences of temperature, humidity, and velocity of the air near the surface as must result from the conditions whose types have been considered. There can be no doubt that rows of trees along canals and about reservoirs must very materially reduce the loss of water through evaporation from their surfaces, and such observations as have been cited make it hopeful that their influence upon the loss of moisture from adjacent fields and their effects upon crops themselves may be of much greater importance, especially in plains regions; but only fuller investigations can mak certain the true relations.

WIDTH OF THE ZONE INFLUENCED BY WIND-BREAKS.

Newell ("Irrigation," by F. H. Newell, page 370), in speaking of the influence of wind-breaks on plains, states that: "It is estimated that every foot of height of compact trees protects a rod of ground; hence a Lombardy poplar wind-break of an average height of 60 feet, properly set out, has a beneficial influence extending practically 1,000 feet to the leeward." In the cases which have been cited the rate of evaporation and the humidity of the air were measurably affected at distances having the same or perhaps a little higher order of value; but when the effect upon the crops themselves is taken as an index, the influence clearly has a wider range, there being in the case of the fields seeded to clover so strong a contrast as 183 to 48 between the distances of 800 and 1,000 feet to the leeward of a grass field, where it appears that the influence must have been exerted in some manner other than by directly modifying either the wind velocity or the humidity of the air. It appears possible that broad continuous naked fields of dry soil or sand on clear days may have a peculiar effect upon air currents sweeping across them. The dry soil or sand itself under such conditions becomes heated and tends to expand the air lying in contact with it, making it relatively lighter than the much cooler and more rapidly moving currents above, and it may be that when these conditions are established the warm air is displaced by the heavier, cooler, and more rapidly moving air from above. Such a current from above, aside from its higher velocity, would be likely to exert a peculiarly parching influence as its temperature rises after coming in contact with the soil. Grass-covered surfaces and damp soil could not be expected to have this effect in so marked a degree, and the result may be that during windy times the air moves across damp surfaces and fields of grass in a less turbulent manner, and as a consequence maintains a higher humidity, which reduces the parching effect. If, however, the turbulency of the air currents at the surface of the ground increases their parching effect, it may be asked whether wind-breaks on plains may not augment the turbulency of the currents and thus, while exerting a protecting influence over a certain distance to the leeward of them, they might not lower the duty of water in the district as a whole and have a prejudicial effect upon average crop yields. Indeed, it appears quite possible that if the wind-breaks were placed too far apart such an effect might be the result, but hardly otherwise. But, even if wind-breaks do exert in general a beneficial effect and tend to increase the duty of water, exact observations are yet too limited to indicate whether the magnitude of such influence would be sufficiently great to make their establishment an economic investment, much less to permit an estimate to be made of what returns might be expected from such an investment. But the problem is capable and worthy of solution.

RATE OF EVAPORATION FROM WATER SURFACES.

There is already a considerable body of data accumulated in this country which indicate the magnitude of the rate of evaporation from water surfaces. A portion of this data has been obtained by measuring the loss of water from tanks floating in reservoirs or canals, but most of them show the loss from tanks three feet square or in diameter and three feet deep, set in the ground so that the rim is within 12 inches or less of the general surface. The mean evaporation during the growing season, April 1 to October 31, as indicated by the records of nineteen stations located within the rectangle 103° and 121° of longitude and 32° and 43° of latitude, is .21 inches per day, 21.149 inches per 100 days, and 47.358 inches for the 214 days in the period under consideration. The minimum evaporation at any stage indicated in the records was .14795 per day, 14.795 per 100 days, 31.66 inches for the seven months; while the maximum (not including two at Wheatland, Wyo., which appear to be exceptional) was .273 inches, 27.295 inches per 100 days, and 58.41 inches, or close to 5 feet, for the seven months, at Logan, Utah. East of the Mississippi we have access to records from but five stations in the rectangle 71° to 90° longitude and 39° 30′ and 44° 30′ latitude, and the mean evaporation has been .145 inches per day, 14.533 per 100 days, and 31.1 inches for the seven months. The records obtained at Boston, Mass., and Rochester, N. Y., are from floating tanks and the mean evaporation was at the rate of 12.09 and 11.448 inches per 100 days, respectively.

In the absence of fuller data, it is perhaps permissible to assume that the ratio of evaporation at 20 feet and 300 feet from the woods, as observed with the Piche evaporometers, is the same as would have been found from water surfaces had they been similarly placed. The mean of the three sets of observations with the evaporometers indicates that the evaporation at 300 feet was 40.73 per cent. greater than at 20 feet. If we consider the probable saving of water by wind-breaks, it appears likely that, except in the cases where the trees exclude the sun from canals or reservoirs, the 40 per cent. represents the maximum saving which could be expected from wind-breaks. With an evaporation of 47.358 inches, given as the mean above, the maximum probable saving would be 18.94 inches of water from a canal or reservoir.

EVAPORATION OF WATER FROM CONTINUOUSLY MOIST SOIL.

During the summer of 1903, a soil evaporometer having an evaporating surface of 11.7 square feet, was maintained at each of four stations: Goldsboro, N. C.; Upper Marlboro, Md.; Lancaster, Pa., and Janesville, Wis. The soil surface was kept continuously capillarily saturated by maintaining a water level in the soil at about 12 inches below the surface, from which an autographic record was secured in each case. The mean evaporation, per 100 days, at the several stations was found to be 21.2, 15.3, and 18.0 inches at the four stations, respectively, given in the order above, or an average of 18.43 inches per 100 days, and of 39.43 inches for April 1 to October 31. If the mean evaporation from similarly moist soil surfaces in the arid regions holds the same relation to that in the humid region as is indicated by the relative rates of evaporation from water surfaces in the arid and humid regions, the total evaporation from a constantly moist soil would average 60.04 inches instead of 39.43 inches, the mean found at the four stations east of the Mississippi during the growing season, computed to 214 days. If five feet is the mean rate of evaporation from continuously moist soil in the West, the maximum saving through wind-breaks would be, according to the observations cited, some 40 per cent. of the total, or 24 inches. It is, of course, never true that the surfaces of fields are maintained continuously as moist as was the case under which the rate of evaporation has been determined. It is true, however, that during the time water is being applied in irrigation and for some considerable time thereafter, the rate of evaporation will exceed that which has been recorded from the surfaces kept capillarily saturated from a water level of one foot below; and irrigators recognize the fact of rapid evaporation during the hot portion of the day through the notably less distance water will travel under a given head before sinking into the ground, than is the case at night and when it is cool.

COMBINED EVAPORATION FROM SOIL AND CROP.

At each of the places where the soil evaporometers were maintained, and at the same time, an entirely similar one filled with the same soil matured ten stalks of maize. The water level in these evaporometers, however, was maintained at 3 to 3.5 feet below the surface, instead of at one foot, and an autographic record of the evaporation was obtained. The time between planting and harvesting averaged 120 days, and during this time the mean total evaporation amounted to 24.15 inches, or a rate of 20.13 inches per 100 days and a total of 43.08 computed to 214 days. On these evaporometers the mean yield of dry matter per acre was 13,881 pounds, 10,000 being a large field yield. This observed mean rate of evaporation is, therefore, likely to be some higher than for ordinary field yields under the same climatic conditions, and the indications are that the evaporation from the field surface under crop may not be quite as large as has been found from the continuously wet soil surface. It may appear impossible that such a relation as this can exist, but the probability of it being true is made clearer when it is understood how great is the reduction in the rate of evaporation from soil surfaces when a thin layer at the top is allowed to become dry, and especially if it is loose and in the condition of an earth mulch. The surface of the soil in the plant evaporometers was maintained in the condition of a good earth mulch three inches deep, and the effectiveness of earth mulches is clearly brought out by the results given in the following table, where the mean amount of evaporation from firm and mulched surfaces of six soil types are given:

TABLE.

Evaporation from Six Soil Types During 28 Days With Surfaces Firm and Under Three-inch Earth Mulches, Computed to 214 Days—Seven Months.

Soil Types.	Surface Firm. Inches.	Surface Under Three-Inch Mulch. Inches.	Difference. Inches.
Sandhill	14.37	1.57	12.80
Selma Silt Loam	22.13	5.92	16.21
Pocoson	25.64	7.11	18.53
Norfolk Sandy Soil	31.87	5.89	25.98
Goldsboro Compact Sandy Loam	40.85	6.73	34.12
Norfolk Fine Sandy Loam	49.79	8.70	41.09

These observations were made at Goldsboro, N. C., in June and July, and they show that there is a very great protection against evaporation afforded by three-inch earth mulches; also, that there is a large variation in the loss of water from different soil types under like conditions through surface evaporation. As the data of this table were obtained during a comparatively dry period, and when the temperature was high, the rates and differences are perhaps as large as are likely to occur, on the average, in the irrigated districts of the West, under such conditions.

In another series of observations made under what must have been conditions closely similar to those of arid climates, columns of capillarily saturated soil 10 feet long were maintained under a continuous draught and without moistening the surface, during 314 days where the temperature ranged between 60° and 90° F. The loss of water which occurred was only determined percentagely, but from the weights of the soils per cubic foot the total evaporation, computed to 214 days, must have been very close to the amounts in the next table:

TABLE.

Evaporation from Ten Feet in Depth of Two Soil Types Under Arid Conditions Continuously During 314 Days—Amounts Computed to 214 Days.

Soil Types.	Surface Firm. Inches.	Surface Under Three-inch Mulch. Inches.	Difference. Inches.
Sandy Loam	2.85	2.49	.36
Heavy Clay Loam	6.55	4.65	1.90

From these observations, and those given in the last table, it is clear that whenever the surface of a field is protected by a layer of dry soil, whether this is firm or loose, the evaporation will be relatively small; but less from the loose than from the firm surface.

It is probable that the losses of water by evaporation from fields in the irrigated districts of the western United States range all the way between 1.57 inches and 50 inches from April 1 to October 31. If this is the case, the maximum conservation of soil moisture, through wind-breaks, is likely to be found to lie somewhere between 40 per cent. of 1.57 inches and of 50 inches, or between .63 inches and 20 inches for the period April 1 to October 31.

The wind-breaks themselves, of course, transpire not inconsiderable amounts of water; but when they are planted about reservoirs and along canals, laterals and head ditches, they may draw largely upon water that would otherwise be lost through percolation or seepage; moreover, the land which such wind-breaks would occupy is often, in part at least, necessarily waste land unless used in this manner. But if it shall be found practicable to make the wind-breaks by using fruit or nut-bearing trees so that an annual income will be realized from them, even though it must be small, the promise of a good investment along this line becomes much better.

"The Forest Tree the Savior of the Soil."

(Paper read by Miss Florence Conway at the Farmers' Institute, held March 22, 1905, at Wirt, Ind.)

Of all forms of vegetation, the one most closely associated with man's history, from the dawn of creation; the one most useful to him in his struggle for existence; the one most replete with encouragement and inspiration, is the tree. Man was associated with the tree in the garden of Eden. He has lived in trees, eaten of the fruit, drunk of the sap, been sheltered from the burning sun and the pelting snows, and made his grave 'neath its protecting bough.

What material achievement of man that has no connection with the tree or some one of its products can you name? Think of the buildings, ships, bridges, and hundreds of devices invented by man, which owe their existence to the wonderful adaptability of the tree. Man's first temples were the forests. Orators, poets, philosophers and prophets have always used the tree in figure and allegory. It is a symbol of a higher inner life. Its upward tendency is an incentive to progress and uprightness; its protective boughs a symbol of charity—

> Sheltered by the sturdy oak,
> The modest violet lifts her head.

And the supreme end of man's attainment is to be fitted to partake of the "Tree of Life."

It would require volumes to record all the uses of the tree, and it would appear that man had utilized them all, but there is one, a most important one, which, if known, is not appropriated nor appreciated by the majority of people. It is the purpose of this paper to call your attention to the "tree as the savior of the soil," and to create an abiding interest in the tree as a redeemer of waste lands. If that can be done its mission will have been accomplished, but the presentation of the subject is in no measure commensurate with its importance.

When we speak of the forest tree as the savior of the soil we infer that the soil has in some way been lost to use, and needs to be restored. There are three classes of waste lands. When the pioneers came to this country they found a richly wooded territory. They set to work to clear the fertile lands, and much fine timber was destroyed. There appeared to them no way of clearing the ground and at the same time preserving the timber. It did not occur to them, standing in those vast tracts of forest, that Indiana would ever want for lumber. How could they foresee the progress the coming generations would make in reducing so great districts to cleared tillable land?

Much of the ground in this part of the State is rolling, so that in a few years after the timber is removed the network of roots having been taken from the ground and crops harvested from it in annual succession, the erosion of the water causes the rich top soil to disappear, and presently the hillsides are bare and seamed with gulleys. It is a patient and careful farmer that can hold his claim to a good hillside farm. If he is not a born farmer, and a genius to out-wit nature, the best part of his lands will soon be in the neighboring valley.

When this occurs to a pioneer of a new rich country he generally pushes to a better location, leaving the old field to work out its own salvation. Thus, what was once a fertile spot becomes what we commonly term "waste lands." It requires Mother Nature, unaided, numberless years to restore such lands. As it is almost impossible to cultivate it to any advantage, in the ordinary way, it is generally allowed to grow up in briers and bushes, or to wash away. Surely such ground as this is waste land, whether 'tis the fault of the present owner or the pioneer.

The second class are lands which are level, not furrowed by ditches, but grown up in inferior grasses and weeds, fields which have been cultivated—no, not cultivated, for cultivate means to improve by labor; fields which have been deprived of their fertility by taking annual crops therefrom, without regard to the proper rotation of same, or the needed rest of the soil; taking all and giving nothing, until the ground is literally worn out, exhausted and can yield no more, and is then abandoned.

The third class, which I shall designate as "semi-waste lands," because only half used, is the small tract of timber land which the farmer reserves as a fuel and post supply ground, the valuable timber having been removed. The best timber is usually taken from the wood in the easiest and quickest manner possible, without regard to injury inflicted upon the young trees, and consequently many seedlings and sprouts, which, if uninjured, would in due time replenish the forest, are destroyed. This wood lot is not sufficiently cleared for pasture, and in it only the inferior varieties of trees are left, so that this ground, which if cultivated properly might be producing valuable trees, is being used in the production of worthless saplings.

There are very few farmers in Jefferson County who do not find themselves possessed of one, perhaps all, of these classes of waste lands.

What is to be done with them? Are they to be allowed to go uncultivated, with their ugly reddish aspect, as a reproach to the owner—the rains continually making deeper gulleys, increasing their unsightliness and unprofitableness? That which is not profit is an expense.

What is to be done with these waste lands? Let nature's own restorer, the forest tree, answer. "Plant me," says the tree, "I will redeem the soil. It may require many years, but I will give to you myself as a compensation to pay for your labor and patience."

The first objection to be raised against the redemption of waste lands by tree planting is the great length of time elapsing before any profit accrues. It will be some years before any pecuniary benefit is obtained, and this is a very serious objection. But think the matter over. Will you make anything by allowing the ground to remain as it is? Is not the ground getting worse every year and depreciating in value? The time will come when lands will not be abandoned as now. The inmoving tide of population will prevent it. If valuable trees are growing, they will enhance the value of the land each succeeding year of their growth, and if you do not reap the fruit of your sowing in dollars and cents some one in the next generation will. You will have the satisfaction of knowing that you have contributed something to the happiness of humanity. We daily reap the benefit of the labor of the past. The only way we can repay our ancestors is to cultivate a like spirit of generosity and sacrifice by doing something for the future. We ought to live, in part at least, for the next. After all is it not nobler to think something of the future than to spend our whole lives in the pursuit of pure gain?

But to return to the practical side of this question. At the present time, and the outlook prophesies the same for the future, there is a great demand for timber to be used for railroad ties, posts and line construction poles. For these purposes large trees are not required. There are several varieties of trees, such as locust, catalpa, walnut, cedar, etc., whose growth is rapid and in ten, fifteen or twenty years a remunerative return from this kind of timber may be had. The trees can be cut in such a manner that the sprouts from the old stump will grow up into a valuable second forest and will again prove remunerative to the owner.

How then does the tree redeem the soil? First, the roots spreading out form a network, which prevents the water from washing the soil away, yet makes it soft and porous. Then the crown of the tree protects it from the sun, causing it to retain moisture, and last of all the annual decay of the leaves thereon enriches it. As a proof of the fact that the soil has been saved—made useful—stands the tree itself, a worthy product and compensation from soil theretofore wholly unprofitable.

It must be understood that single trees can not accomplish much good in this respect. It is their nature to grow in numbers, and a small forest must be planted on the soil that is to be redeemed.

That timber is growing scarce is demonstrated by the kind used and the prices paid for it. That the demand is growing is shown by the increasing number of railroad, telephone and electric lines that are being constructed. That the people realize that the forests are disappearing, and that something must be done to replenish them, is proved by the creation of a State Board of Forestry, by the General Assembly of Indiana in 1901, and the purchase of a tract of 2,000 acres of land as a "Forest Reservation" by the State, in 1903. The greater part of the "Reservation" is uncleared land, but the timber thereon is mostly young trees.

It is the purpose of the State Board of Forestry to cultivate this timber, to plant seeds and seedlings in the cleared portions, and to experiment in general in forest cultivation. The people of the State are to have the benefit of the knowledge gained, and the State treasury of the money which may be made in this matter.